The FOUNDRY

February 1919

CLEVELAND, OHIO.

Vol. 47 No. 2 Whole No. 318

The Foundry Will Be Further Expanded April 1

To Keep Pace with the Tremendous Growth of the Casting Industry of the World it Becomes Necessary to Publish THE FOUNDRY Semimonthly

PUBLISHERS of technical and business periodicals, newspapers and magazines are holders of franchises entrusted to them by the subscribers to their publications. The interests of their readers must be served continuously, or otherwise the franchises are withdrawn automatically.

For more than twenty-six years the publisher of THE FOUNDRY has been entrusted with a franchise by the casting manufacturers of the world. How well this trust has been discharged is reflected by the tremendous growth of this periodical, both in circulation and advertising. Today, it ranks with the world's leading technical publications.

From the beginning, THE FOUNDRY not only represented the state of the art as reflected by current practice, but constantly recorded methods in advance of those generally pursued, whereby the progress of the industry was greatly accelerated.

When THE FOUNDRY made its initial bow to the trade, the rule-of-thumb, guided by the uncertainties of guesswork, to a large extent governed operations. The *whys* underlying casting production, at that time, had not yet been explained. Machine-molding was still in its infancy and brawn instead of brain was the chief requisite of the skilled foundry operative.

What tremendous strides have been made in a quarter of a century are best measured by a comparison of the editorial contents of the first issues of THE FOUNDRY with those of current numbers. Science has replaced the rule-of-thumb and the muscle of the molder now is embodied in mechanical equipment. Chemistry as applied to the founder's art was still in a nebulous state and metallurgy and metallography were sciences practically unknown in their application to foundry work.

Concurrent with the scientific development of the industry has been an unparalleled growth in number of plants and casting tonnage.

For many years THE FOUNDRY was magazine size, but to keep pace with the needs of the art and the great expansion of the trade, it was increased to its present size about 10 years ago. The volume of text matter was practically doubled at that time and since has been added to constantly. Every effort has been made to meet the needs of the industry with the monthly publication of THE FOUNDRY, but this has been found to be impossible of further accomplishment.

Beginning April 1, THE FOUNDRY will appear semimonthly, with dates of publication the first and fifteenth. The volume of text matter available to the foundrymen of the world will be doubled thereby and a greater opportunity will be afforded for the discussion of the many problems so vital to modern foundry practice.

Published in the interest of the entire foundry industry, THE FOUNDRY, with its semimonthly appeal, will have a greater opportunity for the consideration of every phase of casting production than ever before. The several branches of the trade have grown to such proportions that a monthly publication no longer can serve them adequately.

Numerically and in tonnage, the gray iron plants of the world greatly exceed those of any other branch of the industry. In the United States alone about 5,000,000 tons of pig iron are made annually to meet its requirements. The number of individual shops in this country is in excess of 4000 and the practice varies almost as widely as the classes of castings produced. The gray iron foundryman in recent years, has called to his aid the chemist, metallurgist and latterly, the metallographist. His shop operations are facilitated by the advice of the efficiency engineer and wherever possible, he has introduced and is installing mechanical equipment to replace manual labor. A monthly publication no longer is capable of recording the progress of this branch of the foundry industry.

In the last decade, steel casting manufacture has attained a high state of development. With the wide application of the open-hearth furnace, the output has been tremendously increased and the practice is on a highly scientific basis. The side-blow converter also is a large contributor to the steel casting tonnage, while the number of crucible plants show no diminution. Latterly, the electric furnace has been added to the melting facilities of the steel shop and the problems of this new art will be given adequate consideration in THE FOUNDRY when published semimonthly.

Viewed from the standpoint of quality of product, the malleable iron casting industry has made wonder-

ful strides in the last five years. Tests of high grade material now develop physical properties not believed possible a decade ago. The annual output has been greatly increased, plants added to numerically and the practice has been wonderfully improved and changed. THE FOUNDRY, when published semimonthly will devote more attention than was possible in the past, to the problems of malleable iron foundrymen.

Rapid headway also is being made in the introduction of scientific practice in nonferrous metal casting plants. Here the chemist and metallurgist have broken down the barriers of archaic practice and are throwing the spot light upon difficulties that otherwise could not have been overcome. Mechanical equipment also is being resorted to in these plants to increase output and reduce labor. With its large circle of readers in the brass foundry industry, an expansion of this department is imperative and this will be effected by the semimonthly publication of THE FOUNDRY.

The beginning of all foundry operations is in the pattern shop. The progressive patternmaker has been a constant reader of THE FOUNDRY. Every effort has been made to meet his needs, but it has long been realized that it could not be done with the limited number of editorial pages available monthly. Therefore, the patternmakers may look forward to a more extensive consideration of their problems in THE FOUNDRY when published semimonthly.

Although THE FOUNDRY has never claimed to represent the polishing and plating industry, yet these departments of foundries are the largest shops of their kind in the world. As a rule, they are in charge of the foundry executive and the discussion of plating problems in THE FOUNDRY has aimed to give him a general knowledge of the practice which would aid him in guiding the efforts of the superintendent in immediate control of the plating department. This feature also is to be enlarged in THE FOUNDRY.

Because of the time element, articles and items of news interest lose their value in a monthly publication. Market developments, except in a general manner, cannot be adequately treated once a month. Published twice a month, THE FOUNDRY will feature, more than has been possible in the past, news developments as directly affecting all branches of the foundry trade.

Although accurate statistics are not available, it is estimated that approximately 13,000 plants, all over the world are engaged in casting manufacture. Of this total nearly one-half are located on the North American continent and about 40 per cent in the United States. A distribution of more than 10,000 copies monthly shows how thoroughly THE FOUNDRY covers the industry. On Jan. 17, the foreign circulation of THE FOUNDRY was 1467 copies. This was distributed among 36 foreign countries and is proof of the statement that "Wherever Metals are Cast, You'll Find THE FOUNDRY." In far-off Australia THE FOUNDRY is read in 140 casting plants and in New Zealand 43 foundrymen must have this publication to familiarize themselves with the latest practice. Since 1914, Japan has made tremendous strides as an iron and steel producing nation and the 218 subscribers to THE FOUNDRY in this country is proof of its foundry growth. Due to the European war, the foreign circulation of THE FOUNDRY suffered some, yet in stricken Belgium, one lone subscriber managed to secure THE FOUNDRY every month throughout the period of hostilities. France, with the greater part of her industrial territory in the hands of the enemy, retained 75 subscriptions. The detailed figures of the foreign circulation of THE FOUNDRY follow:

Alaska	4
Argentina	7
Australia	140
Belgium	1
Brazil	3
Canada	355
China	12
Colombia	1
Cuba	3
Denmark	5
Dominican Republic	1
England and Wales	343
Finland	2
France	75
Greece	1
Hawaii	8
Holland	17
India	14
Ireland	7
Italy	35
Japan	218
Korea	1
Mexico	12
New Zealand	43
Norway	10
Panama	6
Peru	2
Philippine Island	4
Porto Rico	1
Portugal	1
Scotland	70
South Africa	3
Spain	14
Sweden	34
Switzerland	11
Tasmania	3
Total	1467

Beginning April 1, the subscription price of THE FOUNDRY will be $2 a year in the United States and its possessions; Canada, $3.00, and in other foreign countries, $4. Until April 1, all subscriptions will be accepted and renewed at existing prices. However, upon the termination of subscriptions after April 1, the new rates will apply.

The foundry industry of the world is entering upon an era of activity and growth, which will prove to be unparalleled in its history. Within a few months readjustment will have been effected in this country and the avalanche of dammed-up orders will break upon casting manufacturers in a torrential stream. This will involve better facilities to meet the increased demand, the installation of labor-saving equipment, and the adoption of every advanced method known to foundry practice. The demand for foundry equipment from England promises to be large, while our labor-saving devices and tools will play a prominent part in the reconstruction of the foundry industry of France and Belgium.

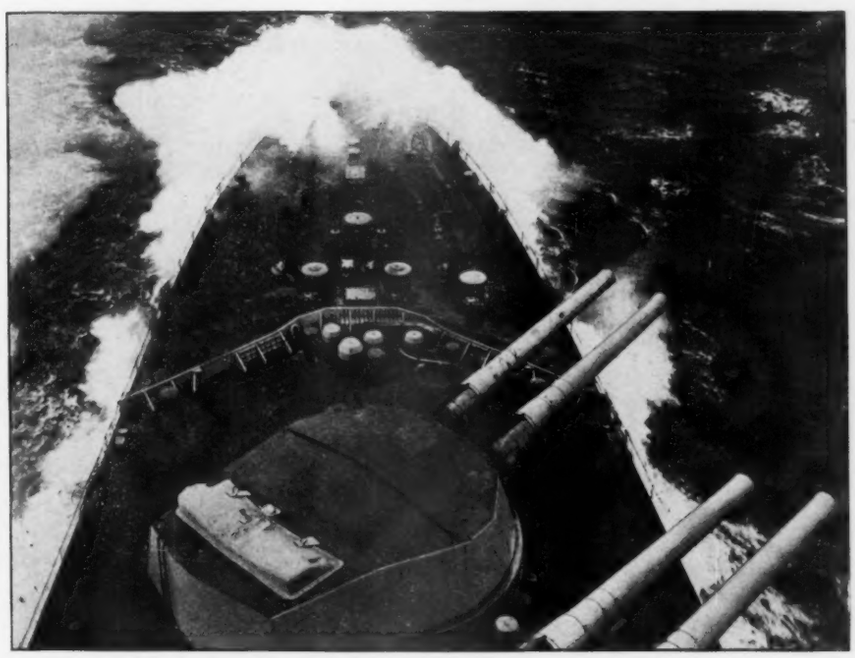
Readers of THE FOUNDRY are equally as much interested in its advertising as in its editorial pages. These constitute an ever-changing and up-to-date catalog of the latest, most modern and highly improved tools to facilitate casting manufacture. Frequency of repetition is one of the underlying principles of successful advertising. This is more nearly approached with a semimonthly than with a monthly publication. Opportunity also is presented for a more prompt appeal for the sale and equipment of a new and improved type, for the disposal of all kinds of machinery, for men, for positions, etc. With the semimonthly publication of THE FOUNDRY the advertiser will be afforded an opportunity to call twice monthly upon the foundry industry of the world, whereas today he is limited in extending his acquaintance to once a month.

British Foundries Are Now Preparing for Peace

A Survey of Conditions in the United Kingdom Based on a Personal Investigation Immediately Following the Armistice

By H Cole Estep

ALTHOUGH four-and-a-half years of war wrought some startling changes in the British foundry business, the general effect of the conflict, and its accompanying forced industrial reorganization, was by no means as marked as in some other branches of the metal trades. This may be because the castings industry of Great Britain was unusually well developed prior to the war and, therefore, on account of its traditions and the complete nature of its plant, not readily susceptible to change. Furthermore, British foundries did not feel the full force of the war's demands as quickly as many other producers. Forging manufacturers for instance, before the end of 1914, were called upon to furnish great quantities of shell blanks at the greatest possible speed. The pressure for tonnage developed much more slowly in the foundry field. This is attested by the fact that government control of the foundries was not found necessary until January, 1917, at which time it was confined exclusively to steel castings. Gray iron and malleable shops were not brought under the direct tutelage of the ministry of munitions until several months later. The end of the war, therefore, found the British foundry business less deeply etched by the acid of official surveillance than many other lines of activity.



BRITAIN'S HUGE NAVY CALLS FOR BIG FOUNDRIES EQUIPPED FOR THE PRODUCTION OF HEAVY STEEL AND IRON CASTINGS

Consequently such changes as took place between 1914 and 1919 followed generally the lines of normal development, accelerated by war pressure. The result is a considerable unevenness in the character of the plant facilities now available, and in methods of operation and management. Within a short radius from Birmingham, for instance, one may find scores of little old shops which have so successfully defied the modernizing influences of the war as to be practically the same today as they were 60 years ago. But nearby are large new plants filled with the latest equipment and managed along thoroughly up-to-date lines. In the industrial struggle that lies ahead, it will be interesting to observe how successfully the conservative old foundrymen of the Black country will survive the onrush of the new methods and new ideas.

The persistence of the small shop up to the present time is shown by the fact that although the total annual output of gray iron castings in Great Britain is only about 2,000,000 tons, there are approximately 3000 gray iron foundries in the British Isles, according to data prepared by the ministry of munitions. To uncover the reason for this large number of small foundries, some of which have a daily output of scarcely over a ton, one must dig down to the well springs of British character. Personal liberty and independence are woven in the warp and woof of English life. The British are a race of men who walk by themselves. Many of them, therefore, prefer to earn modest livings as proprietors of small shops than to triple their incomes by joining large organizations. Consequently, small foundries, while they cannot be said to flourish, manage to exist. The writer visited some plants in Staffordshire in which gray iron, malleable, aluminum and brass castings are all made under one roof, the combined output for a week not exceeding 80 tons.

While most of the small shops produce chiefly gray iron castings, there also are many small steel and malleable iron foundries according to the figures of the ministry of munitions. These statistics show that there are about 100 steel and 100 malleable iron foundries in Great Britain with annual outputs respectively of 160,000 and 52,000 tons. On a basis of 300 working days per year, this shows an average daily production of 5.3 tons in the steel and 1.7 tons in the malleable shops. These figures are on a basis of good castings shipped or delivered. The figures for the United States are interesting by comparison. In America there are 390 steel foundries, with an annual output of approximately 1,375,000 tons, giving an average, on a basis of 300 days per year, of 11.8 tons per plant per day. There are also 249 malleable iron foundries in the United States, with an annual output of 800,000 tons, or 10.7 tons per shop per working day. While we have accurate data as to the number of gray iron foundries in the United States, their production can only be estimated. There are 4325 such shops, with a production of possibly 4,000,000 tons per year, at present, based on figures covering the manufacture of foundry pig iron and the movement of scrap. This works out 3.1 tons of gray iron castings per shop per working day. These

figures show that there are plenty of small gray iron foundries in the United States, although the small shop is not as ubiquitous in this country as in Great Britain, where the average daily output for the gray iron foundries is only a little over two tons.

From the foregoing it should not be assumed there are no large plants in Great Britain. In fact there are plenty that compare favorably in size, equipment and management with the best found in other countries. Some have existed for many years, while others are the products of the war. To the great shipbuilding works on the Clyde, the Tyne and in Ireland are attached some very large gray iron foundries equipped for the production of heavy marine castings of exceedingly intricate character. It is the writer's opinion that the capacity of British foundries for work of this character is fully equal to that of any other country. This is work in which the element of personal skill on the part of the molder plays an important part, and even today in spite of losses due to the war Great Britain is relatively well supplied with molders possessing the necessary qualifications. Consequently, British foundries are able to turn out heavy marine castings at favorable cost.

The stove industry, while less well developed, contains some plants of good size, ranging up to 80 tons daily melt. The tremendous growth of the airplane business under the stimulus of the war resulted in the establishment of a number of fairly large plants, chiefly for the production of nonferrous castings. The same applies to the automobile and motor truck producers, and it is in the automotive field that we find perhaps the greatest willingness to take advantage of machine molding and other modern mechanical aids to foundry production. Some of the most up-to-date foundries in the United Kingdom are found in connection with the automobile and airplane factories in the vicinity of Coventry and elsewhere. But from an American standpoint, the capacity of even these plants is limited and the possibilities for the use of machinery not yet fully developed.

Pioneer Steel Founders

On account of the relatively heavy demand for ordnance and naval castings in Great Britain before the war, the steel casting branch of the foundry industry of the British Isles is exceedingly well developed for the production of heavy work and special heat-treated high-strength material. In the vicinity of Sheffield are some of the largest steel foundries in the world. The molding floor of Hadfield's foundry is 1200 feet in length, and the works of Edgar Allen & Co. is on a similar extensive scale. Those plants specializing chiefly on small steel castings appear to be less progressive. In fact, highly organized light steel-casting plants as we know them in the United States are almost nonexistent in Great Britain. Therefore, a general statement may be risked to the effect that British foundries as a whole are much better developed for the production of heavy than light work. Also there appear to be too many small shops in the miscellaneous jobbing field, and throughout the industry perhaps too great a tendency to rely on hand labor. It should be said, however, that the war has brought about a great change in the attitude of the average British foundryman toward the possibilities of machine-molding and other mechanical aids. There is still considerable room for growth in this direction, and the coming decade very probably will be featured by extensive development in the use of machinery for molding, preparing sand, handling materials, cleaning castings, etc.

In spite of the prevalence of handwork in the mother country, the writer feels strongly that an outsider should not be too quick to criticize or condemn apparently slow-going methods. The reliance of the British foundryman on skilled hands, rather than inanimate machines, has not been due merely to stupidity. In the first place, skilled molders have been relatively more plentiful in the old country than in the United States. The foreign-born workman who cannot speak English is practically unknown in British foundries. There is a greater sympathy, therefore, between master and man and a stronger sense of craftsmanship among the shop hands. Also, while there is a big demand for heavy, complicated castings for ships, etc., there are relatively few orders for huge quantities of light castings from identical patterns. Until recently, also, wages were quite considerably below the American level, and machinery, therefore, less efficient from an economic standpoint. Consequently, criticism can justly be leveled only at those foundrymen in Britain who fail to realize that a new day has dawned, to the needs of which the old hand-power methods are no more sufficient than were the gun and shell supplies of 1914. Candor necessitates the statement that there is a considerable group of such foundrymen in Britain as yet unconverted to the changes brought about by the war. Fortunately, the future progress of the castings industry of the British Isles does not depend on their efforts, and unless they see the hand writing on the wall, they must succumb to the economic pressure of the times.

An Inspiring History

This peculiar coexistence of moss-grown traditions and modern ideas, of antiquated processes and twentieth century methods is a product of the past and only natural in a country that was old before the United States became a nation. It may have drawbacks, but it also means that the historically inclined British foundryman can draw inspiration from a past which fairly teems with great original inventions in metallurgy and shop practice from which the whole world has benefited. Some knowledge of the history of British foundry development is necessary, therefore, to a proper understanding of the industry as it exists today.

In view of the recent prominence of the semisteel shell, it is interesting to note that cannon balls and a large iron gun were cast in London in 1516. By the end of the sixteenth century the skill and experience of the English ordnance founders appears to have given them a leading position, and during the reign of Queen Elizabeth a large number of cast iron cannon were exported to the continent—and there turned

Combining the Old and New

WITH every bomb dropped behind the German lines during the war by the Royal air force, British foundrymen scored a victory. Through their skill in the production of grenades they also were important factors in breaking the defenses of the famous Hindenburg line, while their exceptional ability in the marine field contributed directly to the foundation of allied strength. Their record is one of which every foundryman the world over and particularly their fellow craftsmen in America, should be proud. They formed an exceptionally strong link in that great chain of industrial power which made Britain's war effort so formidable. Their future in the days of peace now dawning over the world is full of promise. The very traditions of the British foundry industry, with its roots running back to the seventeenth century, are inspiring. If the British foundryman is prone to look backward, he does so with reason, and in glancing over his shoulder he does not forget the path ahead. In fact, the ideal of the modern, progressive manufacturer of castings in Great Britain is to create a practice in which is combined all that is best and tried in the old with those elements which are most promising and successful in the new.

against British soldiers in later wars.

One of the earliest English foundrymen, in the commercial sense, was Dud Dudley, who obtained a patent for iron manufacture from James I in 1619. He was also one of the first writers in the world on foundry subjects, and in his book, "Metallum Martis," mentions various castings which his works produced for military and civilian purposes. Common iron castings, however, were not produced regularly in Great Britain until 1709.

It was about this time that the ordinary sand mold was introduced as a result of the researches of Abraham Darby, who with four partners established the Baptist Mills at Bristol. The workmen were Dutch brass founders who had learned the art of making brass castings in sand in Holland. Their first attempts with iron were failures, and considerable loss was incurred in unsuccessful experiments. Finally one night Abraham Darby, with the assistance of a young workman named John Thomas, succeeded in casting an iron pot. This is believed to be the first iron casting made in a sand mold in Great Britain or western Europe. Darby and Thomas made every effort to preserve the secrecy of their method, but like most similar attempts, met with little success, and from that time forward iron founding grew and flourished in the British Isles.

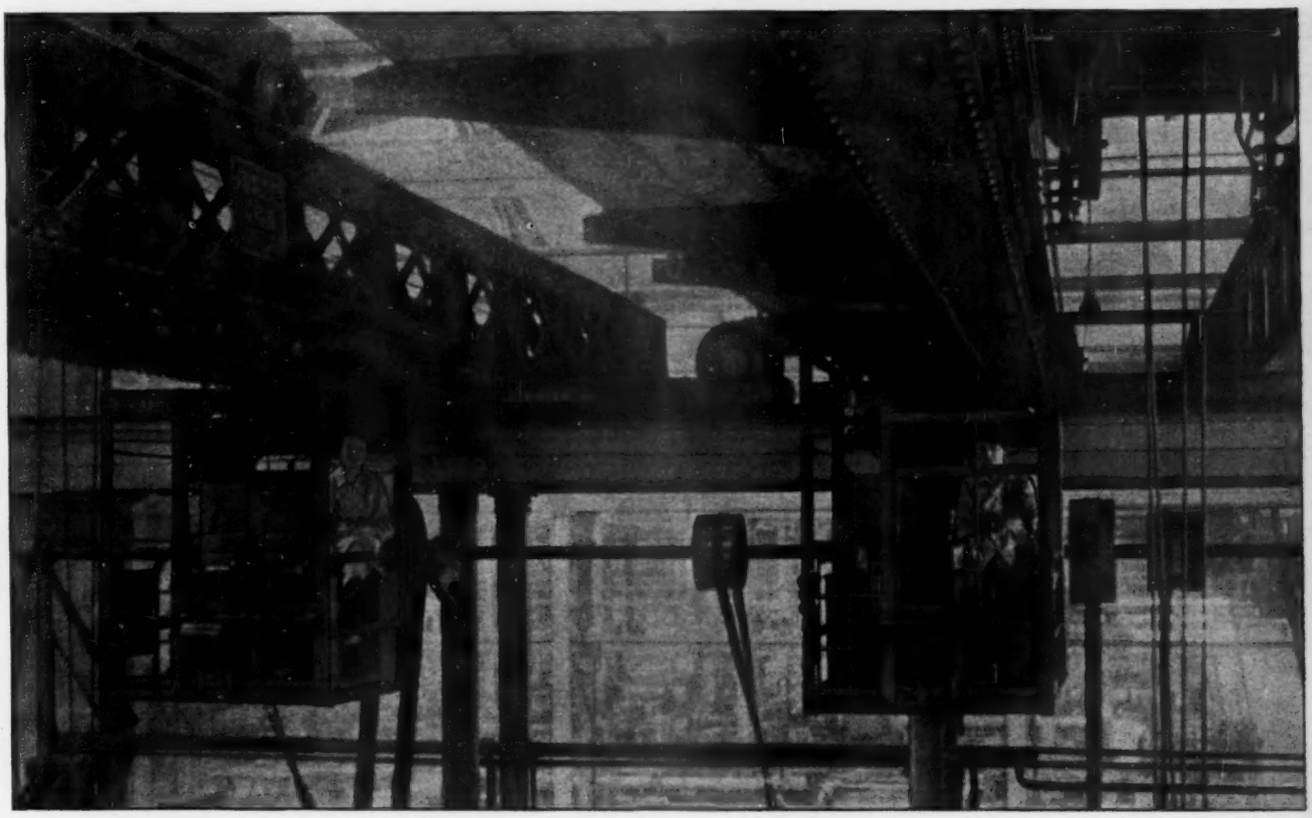
By the middle of the eighteenth century a number of large foundries had been established in England and Scotland. The Carron Works were founded in 1759 and the Clyde Ironworks, in 1788. In all these plants, pig iron was manufactured, and cannon and other iron castings were produced by second fusion. The Carron company was a pioneer in the design and production of castings for the building trades.

Briefly, the foregoing sketches the early history of British foundry practice, which may fairly be said to be the progenitor of the modern castings industry throughout the world. The British foundryman may indeed look with pride on the achievements of his forefathers, and there is sane reasoning in his contention that methods and practices are not necessarily bad because they are old. There is virtue, he claims, in the old as well as in the new. The ideal toward which the modern British foundryman strives in the management of his works, is a proper and balanced combination of what is best in both the oldest and most modern ideas. It is through such efforts that the traditions of his industry acquire a tangible value.

This combination of the old and the new is well illustrated by the organization created for the control of British foundries during the war. It was developed according to the best traditions of the war department, but since the ministry of munitions in itself represents a new departure, the actual management was along up-to-date lines. From the beginning an effort was made to center the foundry control in the hands of practical men who understood the everyday problems of the foundry industry.

As previously stated, British foundries were not brought under government control until January, 1917, by which time the ministry of munitions was thoroughly organized and some hard lessons had been learned as a result of experimenting with inexperienced men in technical positions. Foundry control at first applied only to steel castings, in which the shortage was most severe. Later in 1917, however, it was extended to include both gray iron and malleable shops, so at the close of hostilities, the whole castings industry of Great Britain was completely and strictly under the control of the government, to an extent never reached in the United States. Since the signing of the armistice, this control has been gradually relaxed, although some features are being retained for reconstruction purposes.

The organization is headed by a controller of castings, who has three assistants specializing, respectively, on gray iron, malleable and steel foundries. The names of these men are given in one of the accompanying pages. They are foundrymen of experience, as their



WOMEN OPERATING CRANES IN A LARGE ENGLISH FOUNDRY—IT IS DOUBTFUL IF WOMEN WILL CONTINUE AT TASKS OF THIS CHARACTER UNDER PEACE CONDITIONS

business connections indicate, and now that the war is over are taking a prominent part in the task of steering the British foundry business back to a peace basis quickly and efficiently.

The controller of castings is the only government official who has executive authority over foundries, including the allocating of orders and the control of supplies of raw materials. Confusion was avoided by centralizing all foundry control in this manner. During the war, the policy was to exercise the executive authority of the foundry control department as little as possible and to conduct the work in an informal and natural manner. Reliance was placed on the patriotism and individual initiative of the British foundrymen.

An Experimental Foundry

For purposes of administration, the country was divided into four districts, with committees of local foundrymen, assisted by a permanent secretary, in charge of each district. These districts were as follows: Scotland, northeast coast, Sheffield and southern, the latter including the territory south of Birmingham. All the castings required for war purposes were made in privately-owned and operated plants. The British government built a total of 302 national factories for various war purposes and operated them as government institutions, and although this program included many machine shops, it did not cover any foundries. The controller of castings and his assistants were firmly of the opinion that the best results could be secured by relying on privately-owned plants, backed by individual initiative and patriotism, and this policy was adopted as far as foundries were concerned.

Purely for experimental work, one foundry was built by the government at Branford and operated by the foundry control department. It was fitted up for the production of gray iron and malleable castings and proved of great assistance in working out approved methods of molding and casting grenades, airplane bombs, trench-mortar bombs, semisteel shell, etc. Many experiments were undertaken which would not ordinarily be attempted by a privately-owned concern, and the results were given to the industry as a whole. So encouraging, in fact, has been the operation of this experimental foundry that serious consideration is being given to its continuance.

Reconstruction problems in the British foundry industry are perhaps simpler than in some other branches of the metal trades, because of the more universal character of foundry equipment. New patterns and flasks will have to be provided in a great many cases, but this task is not comparable to that of making new jigs and fixtures for machine shop operations. The demand for castings of all kinds is good, and the foundry control department is lending its aid in providing manufacturers with the necessary raw materials. Scrap is scarce. There is a good supply of foundry and forge pig iron. In fact these grades were not short during the war until the middle of 1918, when semisteel shell and airplane-bomb requirements absorbed a large tonnage. Basic and bessemer irons, particularly the latter, used by steel foundries, are short and are still on an allocation basis. Large orders have been placed for these grades by the British government in the United States and as this tonnage is delivered, it will be distributed by the controller of castings.

Old established plans with permanent business connections and good sales organizations are of course experiencing much less difficulty in re-establishing themselves than new concerns organized during the war purely to handle war contracts. Some of the latter now find themselves obliged to go after business aggressively.

In general, the government, according to an announcement of the minister of reconstruction, is interested in releasing raw materials to foundrymen primarily for the following classes of work:

- Maintenance, repair and replacement of existing machinery and plant in the United Kingdom.
- Maintenance, repairs and renewals for railways, tramways, canals, roads, harbors and docks in the United Kingdom.
- Shipbuilding and the maintenance and repair of merchant ships and fishing vessels in the United Kingdom.
- Manufacture of agricultural, milling, food-producing, mining and textile machinery, machine tools and equipment used in the public utility services of the United Kingdom.
- Manufacture of approved orders placed by the governments of the United Kingdom, British Dominions or the allies.
- Manufacture of good for export, subject to such government regulations of export as may from time to time be found necessary.

The foregoing classifications include a wide variety of products, and with raw materials secured, the only remaining problem is that of labor.

The Ever Present Labor Problem

British foundrymen are fortunate in that their labor, compared with that available in the United States, springs from a single national stock and is uniform in character and language. Also, as previously suggested, the average British foundry workman seems to have a well developed sense of craft responsibility and a pride in his manual skill. The foundry trades in England were not as extensively diluted during the war by female labor as some other lines of manufacture. Nor were women employed in British foundries to anything like the extent they were in France. It is not now believed that the task of readjusting the female labor situation in the British foundries will be a specially serious one. As one of the permanent results of the war, women probably will be employed more extensively than ever before for coremaking and some light molding, but it is expected that most of the ordinary work in the molding room, cleaning department and in connection with the melting of metal will continue to be performed by men.

Demobilization of the army is proceeding slowly, but the labor situation has eased perceptibly since the signing of the armistice. At the same time there is such a demand for men that there is no trouble with unemployment in the foundry trades in the United Kingdom.

Wages, of course, continue high, with no prospect of early change. The government has guaranteed the existing scales until May 1, 1919. In jobbing foundries in England molders are now earning an average of $25.75 a week,

Government Control

DURING the war British foundries were completely controlled by the government through the authority of the ministry of munitions. Orders were allocated and raw materials provided. An experimental foundry was operated in which improved methods of producing grenades, air-bombs, semisteel shell, etc., were developed. Bureaucratic methods were avoided, and reliance was placed on the energy, resourcefulness and individual initiative of patriotic foundry owners and managers. This policy worked so well that no government-owned foundries were built, although 302 national factories were constructed for other purposes. Today the officials of the foundry control organization are taking a prominent part in the work of reconstruction, which is now in full swing in Great Britain. These men are as follows:

CONTROLLER OF CASTINGS
G. Ernest Wells
Edgar Allen & Co., Sheffield

ASSISTANT, STEEL FOUNDRIES
Capt. H. Sheel
Vickers Ltd., London

ASSISTANT, MALLEABLE FOUNDRIES
W. Turner
J. Maddock & Co., Open Gate

ASSISTANT, GRAY IRON FOUNDRIES
J. Shaw
Past President, British Foundrymen's Association,
Cartlef, Kings Winford, near Dudley

on a day rate basis; laborers are paid $12 to $15 a week, these rates being about double the prewar scale, but still appreciably lower than the average American wage. In stove foundries on piecework, the men are guaranteed a minimum of $13.50 a week, although their average earnings are in the neighborhood of $25 to $27.

Not Easy to Speed-Up

The chief fundamental difficulty with British foundry labor appears to lie in its lack of appreciation of the necessity for maintaining production—for getting out the work—to use a Yankee expression. The general statement has been made that the average American molder turns out 50 per cent more work in a day than his British compatriot. Recent observations in English shops would indicate that this statement has a considerable basis of fact. It is also true that the British workingman has an antipathy to the introduction of machinery, even though the machine may lighten his labors appreciably.

These are serious drawbacks which many progressive foundry managers in the United Kingdom are struggling hard to overcome. Their labors are not lessened by the fact that there is still a considerable body of foundry proprietors, particularly those owning small shops, who have little sympathy with the introduction of machinery or modern methods of production.

Trade union ideas on the limitation of output also enter prominently into this phase of the problem of production. Before the war these restrictions were a serious menace. It is now a question whether the British workingman has learned from experience that his antebellum ideas on this subject not only threatened his own prosperity, but that of his country as well. The war has shown that prosperity and high wages, with plenty of jobs all around, go hand in hand with huge production and a big output per man, aided by machines wherever possible; but it is doubtful whether the lesson is yet learned.

At present British foundrymen are obliged to agree with representatives of the union as to what constitutes a day's output from each pattern. In the stove business, before the war, limitations were so severe that certain ordinary stove fronts, molded on the floor by hand, were limited to seven flasks a day. Even now the output is only 15 molds a day in the shop in question, although there is no doubt that the use of hinged match-plates, or simple squeezer machines, together with improved methods of bringing up and preparing the sand, would make it possible to get out 90 or more molds a day, to be conservative.

As another example of the limited outputs prevailing in some English foundries, the case of 60-inch locomotive driving-wheel centers might be cited. In a certain shop this work is done entirely by hand, including the ramming, and the output from two men in nine hours is seven molds a day.

The foregoing, while not exceptional, represents, in the opinion of the writer, a passing stage of British foundry practice, and is not indicative of what may be expected to develop in the next few years. The war has had a tremendous leavening effect, and the possibilities of machine production are now being given serious consideration on every hand. It is realized by many British foundrymen that the jar-ramming machine, which is almost unknown in the United Kingdom, has great possibilities; and it is also appreciated that molding-machine installations must be backed up by adequate auxiliary equipment.

Looking to the Future

On the metallurgical side, British foundries appear to be more up-to-date than in the molding departments, and in most shops scientific cupola operation and furnace practice has been studied thoroughly. The stove foundries use, perhaps, a rather expensive mixture, a representative analysis of the stove-plate being as follows: Silicon, 3.50 per cent; sulphur, 0.05 per cent; phosphorus, 1.50 to 1.60 per cent; graphitic carbon, 3.70 per cent. To obtain this result, the mixture is proportioned to contain 30 per cent home scrap and 70 per cent pig iron, the latter being one-third No. 2 and two-thirds No. 3 iron. The No. 2 pig contains about 2.75 per cent silicon, 0.40 per cent manganese and only a trace of combined carbon. Ferrosilicon also is used. The coke charges are 140 pounds per ton of iron in a 50-inch cupola. The cupola is only 42 inches in diameter at the hearth, and the bed charge of 1700 pounds brings the coke up to a point 24 inches above the tuyeres.

The large steel foundries in the Sheffield district, and elsewhere, are particularly advanced in their melting practice. These plants have for years given special study to the production of high grade alloy steels for ordnance, naval and other purposes, and in this branch of work British shops are possibly superior to any others in the world. Heat-treatment has been studied exhaustively, both from the standpoint of pure science and in its practical aspects as applied to commercial work.

Acid lined open-hearth furnaces are favored for steel castings, although a heavy tonnage of high grade work is also turned out on basic bottoms. Furnaces of about 40 tons capacity seem to be popular. Electric melting is growing in favor. Relatively few converter castings are produced. It is interesting to note that in one of the most prominent steel foundries in England, the ferromanganese which is added in the ladle in making manganese-steel castings, is melted in a cupola about 30 inches in diameter provided with a special lining.

Some small foundries in the Birmingham district melt malleable iron in small 6-ton regenerative open-hearth furnaces, which are charged by hand. Hematite or low-phosphorus pig iron forms a prominent part of the mixture. These furnaces are fired by producer gas, small producers being employed, and the fuel consumption is said to be 500 pounds of coal per ton of iron melted.

British foundrymen as a rule devote considerable attention to the preparation and mixing of their sand. This problem also has been investigated thoroughly in England from the scientific standpoint. The steel founders use sand as high in silica as possible, with only enough clay added to form the necessary binder. Good silica sand is cheap and abundant. Iron founders employ centrifugal mixers and sand aerating machines in a good many cases. The muller type of sand mill is also extensively used in gray-iron and malleable shops as well as in steel foundries.

Sand is Carefully Prepared

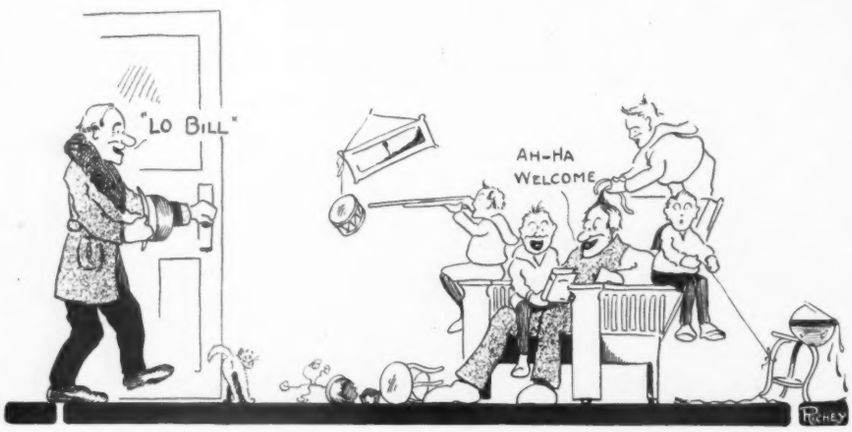
To recapitulate, British foundries appear to be fully abreast and in some important particulars ahead of the times in their metallurgical practice and methods of preparing and mixing sand. They are less satisfactorily developed, from an American standpoint, in the molding room. Much work is done on the floor by hand that apparently could be handled to better advantage on molding machines. Jar-ramming machines are rare. Most of the squeezer machines are hydraulic, and many of those in use are of German manufacture. A few very large hydraulic squeezer machines with 80-inch tables are employed in the steel-casting shops. Modern combination machines, jar-ram and roll-over, jar-ram and squeeze, roll-over and pattern-draw, etc., seem almost unknown. Facilities for handling materials and cleaning castings mechanically also appear limited, and sand-blasting has not as yet been extensively adopted. It is of betterments along these lines, however, that most British foundry owners and managers are thinking seriously at the present time. Plans are being developed on every hand for the extensive improvement of shop facilities, to the end that British casting manufacturers may maintain their important position in the engineering world.

Bill Throws Some Light on Solomon's Temple

How the Big Brass Columns in Front of the Structure Were Made was a Mystery to Bill Until He had to Cast a Large Base for a Smokestack

By Pat Dwyer

I RECEIVED an invitation from Bill lately to come over to his house to a christening. Knowing from experience how helpless and foolish the average male parent feels on occasions of this kind, I decided immediately to attend and lend him such moral support as lay in my power. I got the four essentials for a visit of ceremony, namely, a bath, a shave, a haircut and a shoe shine; and thus fortified, I made my way to Bill's house. I found him all sprawled out in a big Morris chair, with one little cherub in his lap, one perched on each arm of the chair, and a fourth little man standing up behind and gravely trying to tie a pink bow in old Bill's hair. I certainly do like to see a father and his children on terms of friendly intimacy. You may talk of the love of a man for a maid, a husband for his wife or a mother for her children. They are all very well, but for the real genuine article give me the feeling a father has for a little child, boy or girl, between the ages of 2 and 5. Am I right?



MRS. "BILL" WAS NOT AROUND

"Faith," said I to Bill, "I wonder how old J. H. Solomon used to spend his Sunday afternoons. With 700 wives and 300 concubines, he must have had more children than the old woman who lived in the shoe."

"Well," said Bill, "my opinion of Sol is the same as that of the old colored lady who when she first heard the story of all the ladies who boarded at his house, rose up and said, 'My golly! deh wah real men in dem days.'

"But speaking of Solomon—did you ever figure out how he made those big brass columns for the front of his temple; or the rest of those castings which are described so minutely in the *First Book of Kings,* chapter VII"?

"I know one thing, it was not a foundryman who wrote that chapter. I guess it must have been the draftsman. He gives the most minute details of the size and shape, and all the ornaments that were hung around them, and then dismisses the most important point of all by simply remarking: 'In the plain of Jordan did the king cast them; in the clay ground between Succoth and Zarthan.'

"When you consider that these columns were 27 feet long, 6 feet in diameter, with a metal thickness of 1-inch and weighed about 10 tons, you will admit it was some job. That master mechanic he had, Hiram of Tyre, must have been a bird. I don't think that Schwab of Bethlehem, or Carnegie of Pittsburgh, had anything on him." I interrupted here to remark, "What's the use of worrying over that old stiff? Solomon is gone, Hiram is gone, and the columns are gone; and perhaps the whole thing is a pipe dream."

"That does not make any difference," said Bill, "I never read of an unusual casting, or saw one, that I did not want to know how it was made; and I like to mull the thing over in my mind until I figure out how I would have made it myself. I often find that some ideas I form about theoretical jobs, come in right handy for some actual jobs that I run up against once in a while. For instance, I adapted the idea which I think Hiram used in pouring the columns, to the pouring of a smokestack base I made one time."

"Never mind the smokestack base for a minute," I said, "you are dismissing the column question as briefly as the draftsman you were kicking about a few minutes ago. How do you reckon they molded and cast those columns?"

"Well," said Bill, "I'll tell you; of course, you must remember they had no traveling cranes, no iron flasks, nor big iron barrels to sweep up a loam core on. So taking it by and large, I guess they cast them in loam on end. First they dug a pit about 10 feet in diameter and 30 feet deep. They swept a level bed on the bottom, with a seat around the edge to locate the cheek; while they had the spindle in, they built-up the core to a height of 5 feet, and swept a seat on the top end to receive and locate the next section. They built charcoal fires all around to dry this part of the mold. Up on the level ground they set up 10 spindles and swept up two level beds. They dried these, and then they built-up the cheek on one, and the core on the other, in sections 5 feet high; as each section was finished, they lifted it off and dried it and lowered it into place until the required height was reached. They covered the opening on the top with a row of key brick, with a 1-inch hole in each to act as a gate. They then rammed the pit up solid the same as you see hydraulic cylinder molds rammed up at the present time. They built a trough, or basin, all around the top, about 7 feet in diameter on the inside, 21 inches deep and 18 inches wide. From this, narrow gates were cut leading to each of the pop gates.

"The next step was to melt the brass. They built 70 small furnaces, put a 300-pound pot in each one, and before the day was over the stuff was ready. They plugged all the gates, poured all the brass into the basin, pulled the plugs and the law of gravity did the rest. I expect they had a few kegs of beer on the job and

after these were emptied, they punched the time clock and called it a day.

"Now, getting the casting out of the pit was another proposition. I think they dug a long incline from the bottom of the pit to the level ground. When all was ready, they fastened ropes to the top of the casting, and with a long pull, a strong pull, and a pull altogether, they tipped it over. They then put rollers under it, and by pulling in front, and blocking behind, they finally got it up on the level ground. There it was chipped and cleaned. It was a simple matter to roll it over the ground up to the temple. There, with long levers and blocking they set it upright where it belonged.

Time Was No Object

"I don't know how long it took to do it, but time was no object in those days; and as for labor, they had more men around that job than they have today at the Hog island shipyard, and they were not paid riveters' wages either.

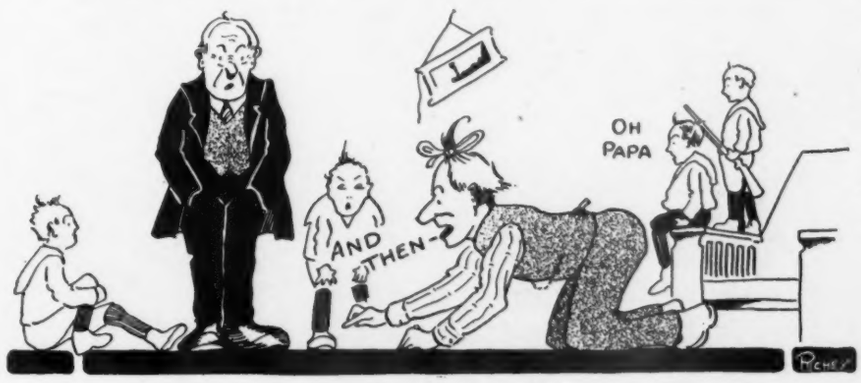
"What I wanted to tell you about, was a smokestack base I made one time, and how this stunt of Hiram of Tyre in pouring the column gave me an idea of how to cast it. I was working in a small shop at the time, and business became so slack that all the hands were laid off except one apprentice, a general utility man who combined the offices of chipper and furnaceman, and myself. We pegged along for a week or so. Then one day the manager said he had an order for a smokestack base, 10 feet 8 inches square, with an 8-foot opening in it, and asked me if it were feasible to make it. I said, 'Sure, bring it along.' The patternmaker made a skeleton frame for the flat part, and a segment to go around the inside to form the flange to which the stack was to be riveted. We bedded it in the floor, and as there was no cope large enough to cover it, I used one 11 feet 6 inches x 6 feet, and two smaller ones, each 6 feet square. The two small copes had handles on two sides, and trunnions on the ends, so they could not butt up close to the long cope. I could not slip cake cores in between, because the handles came right in the way. After the copes were rammed up, staked and lifted off, I blocked up an iron plate under the edge and projecting about 6 inches all along where the opening of the mold came.

"I then hung hook gaggers along the outside and rammed core sand to a thickness of 4 inches. Then I built fires under these plates and dried the overhang. After these were dried the plates were removed, leaving the face of the copes projecting 6 inches past the outside. The bottom of the mold was then finished and the copes replaced.

"I fastened down one side of the long cope with hook bolts attached to staples which were anchored in a long, narrow pit alongside. The other side, and the two small copes, I weighted down with two long iron copes which were used to make columns. I rammed them full of sand before putting them on for additional weight. Then I built a long basin from one side and connecting with two upright gates near the center. I figured the casting would weigh about 6500 pounds and the only big ladles we had were of 4000 and 1000 pounds capacity, respectively. Here is where Solomon's column fitted in. I got an iron flask, 3 feet square and 2 feet deep, cut a 4-inch hole in one side near the bottom for a tap hole, and lined it up with clay the same as a ladle, and dried it. I set this under the furnace spout, with the tap hole in the box opening into the long basin leading to the gates. The furnace was lined to 26 inches and we used six charges of 1200 pounds each. When all was ready we put on the fan and let her go. When all the iron was melted and in the box, I tapped it through the hole already referred to, and a beautiful stream ran right down just as good as if poured from a ladle. The next day we stripped it, lifted it out and cleaned it. It weighed a little over 6500. I thought it was some job considering the circumstances. When the manager saw it, all he said was: 'Well, I see you got it alright Bill!' Can you beat it?"

About this time the other guests began dropping in and Bill had to drop the foundry business to attend to his duties as man of the house. The new arrival was passed from hand to hand and duly praised. I asked Bill what he intended to call it, and he said he was undecided whether to call it Solomon or Hiram. When Mrs. Bill was appealed to, she vetoed both of them, told Bill he had no sense and said the child's name was to be Mary Agnes.

AND BILL TOOK THE COUNT



HIRAM OF TYRE GAVE ME AN IDEA

Institute of Metals Will Hold Winter Meeting

The winter meeting of the American Institute of Mining Engineers, which will be held at the headquarters of the society in New York, Feb. 17 to 20, will include also a meeting of the Institute of Metals division of this organization. The hotel headquarters for the Institute of Metals division will be at the Seville, Twenty-ninth street and Madison avenue.

Death of Major Joseph T. Speer

MAJ. JOSEPH T. SPEER, one of the leaders of the foundry industry of the United States, past president of the American Foundrymen's association, and prominently identified with the great organized movements on technical development in that field, died at Pittsburgh, Jan. 5. He had been in poor health ever since he suffered a stroke of apoplexy at his country home in Garrettsville, O., in 1916. At the time of his death, he was chairman of the Pittsburgh Valve Foundry & Construction Co., and one of the prominent figures in Pittsburgh industrial circles.

Major Speer and the interests with which he had been affiliated were pioneers in several branches of the foundry business. He himself made the work of foundry advancement in all its allied lines, a life undertaking. He was born in the fourth ward, now downtown, Pittsburgh, and received his education in the old fourth ward school and Western university, now the University of Pittsburgh. Immediately after graduation, he became connected with the firm of Hall & Speer, plow manufacturers, of which his father, Alexander Speer, was senior member. After four years, during which he served his apprenticeship as patternmaker, he spent four months in Europe. He returned to Pittsburgh, with the firm of Hall & Speer, and became an active foundryman, devoting his attention entirely to the foundry end of this business, which in 1874 was changed in title to Alexander Speer & Sons. William W. Speer, a brother of the major, became the head of the business on the death of Alexander Speer, in 1876. William W. Speer and Joseph T. Speer continued the business until in 1878 when the manufacturers in the western and southwestern parts of the United States, taking up the manufacture of plows, limited the field to such an extent that the firm found it necessary to expand to foreign markets. In 1878 Major Speer took charge of South America, Central America and the West India islands, and established a house at Havana, becoming the pioneer plowman in these territories. In this connection, he became thoroughly familiar with the agricultural resources of the tropics and was known throughout Cuba, Central and South America by the name of Arados Hall, the Spanish name for Hall plow. He remained in the tropics until the breaking out of the Spanish-American war in 1896, when the foreign interests of the company were sold to the Spanish partner.

Returning permanently to the United States, Major Speer succeeded to the management of Alexander Speer & Sons in 1897, when his brother, William W. Speer, became president of the Dollar Savings bank of Pittsburgh. He continued that position until November, 1899, when the present Pittsburgh Valve Foundry & Construction Co. was organized by the consolidation of the firms of Atwood & McCaffery; Shook, Anderson Mfg. Co.; Pittsburgh Valve & Machine Co.; the pipe fitting department of Wilson & Snyder and the foundry department of Alexander Speer & Sons. The late Henry M. Atwood was president of the new company for two years when the position of chairman of the board of directors was created and Major Speer succeeded to the presidency and active management. Upon the retirement of Mr. Atwood as chairman of the board three years ago, he was succeeded by Major Speer. From this time Major Speer not only was actively connected with the foundry business in his own plant, but he also became identified with the progress of the business throughout the country. He bent his endeavor to the improvement and advancement of the business, particularly as applied to the manufacture of gray iron and steel in high pressure usages. He was among the first to take up the study of semisteel which he applied to the manufacture of valves. Major Speer secured his military title through his service with the old Duquesne Grays, having joined Company B of this organization as a private in 1874, and continued through the reorganization of the Pennsylvania guards when the Duquesne Grays became a part of the Eighteenth regiment. He won various promotions until he reached the rank of

(*Concluded on page* 65)

MAJOR JOSEPH T. SPEER

Reducing the Malleable Iron Annealing Period

Experiments Were Made in an Electric Heating Furnace and Rate of Heating, Maximum Temperature, Rate of Cooling and Other Important Factors Were Investigated

By Major A E White and R S Archer

THE heating cycle employed for the annealing of malleable castings varies considerably among the different foundries, even when the same grades of white or hard iron are used. The reasons assigned by the annealers for their particular variations of the process are often obscure. This is only natural when it is considered that their sources of information, for the most part, lie in accumulated traditions and in workshop experiments carried out in furnaces with uneven temperature distribution and, until recently, poor means for measuring temperatures.

These variable factors tended to discourage or to render ineffectual any investigational work which might have been undertaken.

The present investigation was not undertaken, however, with any idea of showing the practical annealer how to produce good malleable, for as in so many other branches of metallurgical practice, the art has developed ahead of the science. The purpose, rather, was to throw such light on the metallurgical principles involved that the same grade of work might be produced with greater efficiency as to annealing time and uniformity of product under known conditions.

Presented at the Milwaukee meeting of the American Foundrymen's association.

Before proceeding with the results of the present work, a brief discussion of the composition, properties and constitution of malleable castings is presented.

Where Experiments Were Made

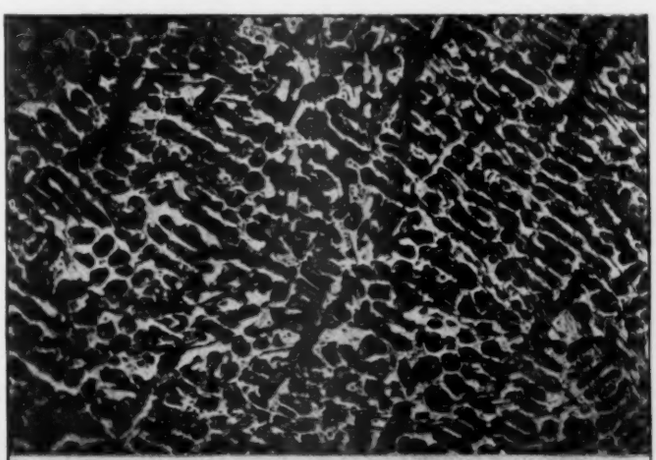
The work leading to the preparation of this paper was done at the chemical engineering laboratories of the University of Michigan. The experiments were performed by Robert S. Archer, holder of the fellowship in metallurgy established by the Detroit Edison Co., with the assistance in a very general way, of C. F. Hirshfeld, chief of research, of the Detroit Edison Co., and Maj. A. E. White.

The proper composition of good white iron castings for malleable is indicated by the following limits:

	Per cent
Combined carbon	2.60 to 3.00
Graphitic carbon	none
Silicon	0.45 to 1.10
Manganese	0.25 to 0.40
Phosphorus	under 0.225
Sulphur	under 0.06

On annealing no chemical change takes place except the conversion of combined carbon to graphitic carbon and a slight reduction of total carbon by oxidation.

The change in constitution is shown in the photomicrographs, Figs. 1, 2 and 3. Figs. 1 and 2 show sections of the white iron used in these experiments. The micro-constituents are cementite (white) and pearlite (dark in Fig. 1, and laminated in Fig. 2). Fig. 3 shows a specimen of a commercial malleable of similar composition and thickness of section. The black areas are graphitic carbon in the form characteristic of malleable, in which form it is known as *temper carbon* or *annealing carbon.* The softening of the casting by annealing is due to the elimination of the hard and brittle cementite. As to physical properties, malleable occupies a place between gray iron and steel. The tensile strength varies from 35,000 to 60,000 pounds per square inch and elongation from 3 to 10 per cent.



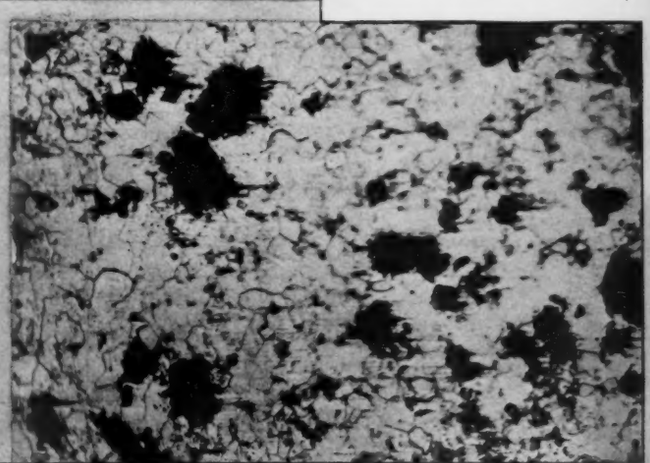


FIG. 1—WHITE IRON ETCHED WITH NITRIC ACID—MAGNIFIED 100 DIAMETERS

FIG. 2—WHITE IRON ETCHED WITH NITRIC ACID—MAGNIFIED 1000 DIAMETERS

FIG. 3—COMMERCIAL MALLEABLE ETCHED WITH NITRIC ACID—MAGNIFIED 100 DIAMETERS

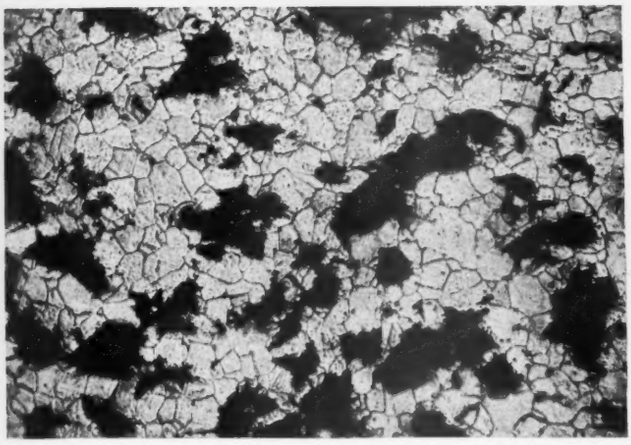


FIG. 4—MALLEABLE SPECIMEN ANNEALED EIGHT HOURS—MAGNIFIED 100 DIAMETERS

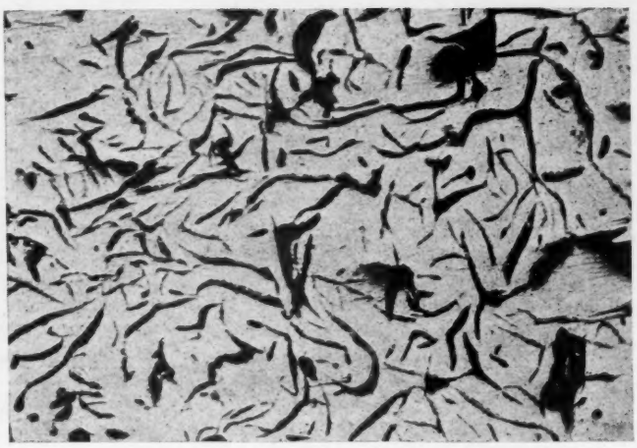


FIG. 5—GRAY CAST IRON UNETCHED—MAGNIFIED 100 DIAMETERS

The authors recall a test in which the tensile strength was 52,000 pounds per square inch and the elongation 28 per cent. This ductility, of course, is unusual. The transverse strength on a 1-inch square bar on a span of 12 inches is from 3000 to 5000 pounds with a deflection of ½ to 2½ inches.

The present experiments were carried out with one particular grade of white iron. The analysis of the material was as follows:

	Per cent
Combined carbon	2.90
Graphitic carbon	none
Silicon	1.05
Manganese	0.35
Sulphur	0.035
Phosphorus	0.11

This metal was melted in an air furnace and cast from a single ladle into sections ⅜-inch thick. The annealing experiments were carried out in a wire wound electric furnace, using a calibrated platinum rhodium thermocouple for temperature measurements. The rate of annealing was measured by the decrease in the percentage of combined carbon, as determined by difference between total and graphitic carbon. The results of the various treatments were followed by microscopic examination.

The commercial annealing cycle may be said to consist roughly of three stages: Bringing to heat; holding at heat and cooling. Practical men usually insist on a slow heating, a low annealing temperature, and a very slow cooling. The reason for the slow heating appears particularly obscure; and, while it is well known that a fairly low annealing temperature is necessary for the production of good malleable, and that slow cooling is necessary to avoid hard castings, the exact limits in these respects appear to be in some doubt.

It was hoped, therefore, to clear up some of the following points:

Effect of rate of heating.

Maximum permissible annealing temperature.

Time necessary at this temperature.

Necessary rate of cooling.

Temperature below which the rate of cooling is immaterial.

The first of these questions to be considered was that of the time necessary to complete annealing at various annealing temperatures. Samples of white iron were brought rapidly to heat and held for various lengths of time, followed by quick cooling. Drillings were then taken and analyzed for combined carbon. On heating at a given temperature for various lengths of time, the percentage of combined carbon gradually decreases and finally becomes constant. This constant value depends upon the annealing temperature, and, for any temperatures used in practice, varies from about 0.75 to 1.00 per cent, increasing with the temperature. If the annealing temperature is below the A_1 point, which is at 1365 degrees Fahr. for the iron used in these experiments, the combined carbon is completely decomposed.

The time required to reach such equilibrium conditions at any given temperature cannot be determined exactly, because the rate of decomposition of the combined carbon becomes very slow as the end of the process is approached. The time required to complete 90 per cent of the process at any temperature, however, can be determined within about 10 per cent. The curve illustrated in Fig. 12 shows the time required to complete 90 per cent of the decomposition of combined carbon possible at the various temperatures in question.

Since it is impossible to anneal a white iron completely, that is, to change all the carbon to the graphitic form, above the critical temperature, 1365 degrees Fahr., the annealing must always be completed below this temperature.

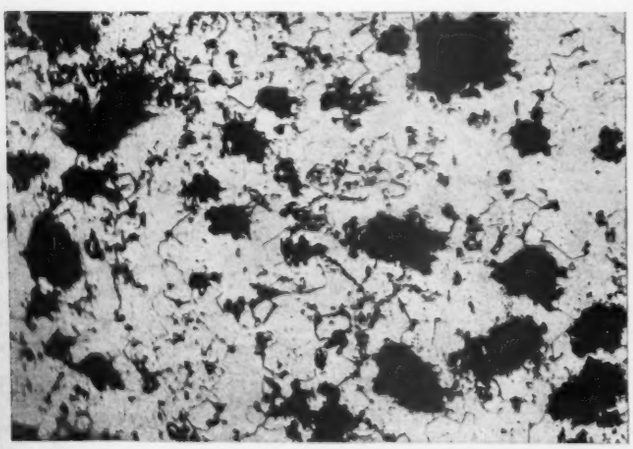


FIG. 6—COMMERCIAL MALLEABLE, NITRIC ACID ETCHED—MAGNIFIED 100 DIAMETERS

FIG. 7—COMMERCIAL MALLEABLE ANNEALED AT 2050 DEGREES FAHR., UNETCHED—MAGNIFIED 100 DIAMETERS

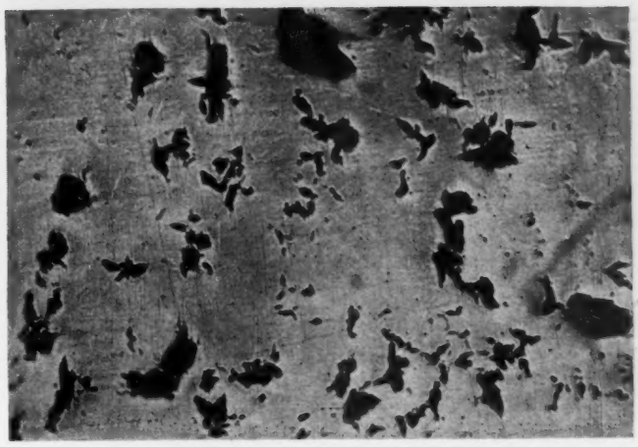


FIG. 8—MALLEABLE ANNEALED AT 1950 DEGREES FAHR., UNETCHED—MAGNIFIED 100 DIAMETERS

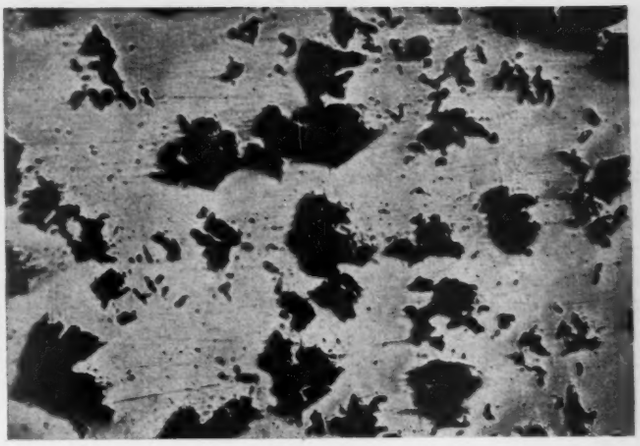


FIG. 9—MALLEABLE ANNEALED AT 1800 DEGREES FAHR., UNETCHED—MAGNIFIED 100 DIAMETERS

In practice this is done by cooling slowly through the range immediately below critical. It was found that cooling at the rate of 20 degrees Fahr. per hour through the critical range and down to about 1200 degrees Fahr. was sufficient to complete the annealing.

With this information it was possible to plan annealing treatments of wide variations as to time and temperature, with reasonably certain results, as far as the elimination of combined carbon was concerned. Thus a white iron could be completely annealed by heating at 1275 degrees Fahr. for eight days, or the combined carbon could be completely eliminated in a few hours by a short, high heat, followed by a slow cooling through the critical range. Fig. 4 is a photomicrograph of a sample annealed by holding two hours at 1800 degrees Fahr., cooling through the critical, and holding for five hours between 1300 degrees and 1350 degrees Fahr. The total time in the furnace was eight hours.

Up to this point in the work, the only consideration had been annealing from the chemical point of view, that is, the sole object had been to eliminate combined carbon. It was realized, of course, that the possible variations in annealing treatments were limited both by the necessity for producing good malleable castings and by the inflexibility of the large furnaces used in the malleable foundry. It was known in a general way that the use of excessively high annealing temperatures in practice was fatal to the production of good malleable, as well as causing undue destruction of annealing pots and furnace arches. The authors, however, were not aware of any strictly metallurgical reason why a casting, properly packed to prevent oxidation and warping, should show inferior physical properties because of annealing at a high temperature. Experiments, therefore, were made to determine the effect of annealing temperature upon physical properties. For these experiments the white iron was cast in the shape of the test bar recommended by the American Society for Testing Materials. The composition was similar to that already quoted.

It was found that the physical properties deteriorated with increase in annealing temperature. The elongation was most affected, although, as has often been noted, the tensile strength fell with the elongation.

Microscopic examination of the annealed specimens showed the cause of this difference in properties to be due to a difference in the forms of graphitic carbon, or temper carbon, produced at the various annealing temperatures. Fig. 5 is a photomicrograph of a piece of gray cast iron. The constituents are the same as those of an annealed malleable—graphitic carbon in a matrix of impure iron known metallographically as ferrite. Fig. 6 shows a sample of commercial malleable. The particles of temper carbon are in a rounded form, so that they do not break up the continuity of the metallic matrix. This form of graphitic carbon is considered quite distinct from that of the gray or mottled iron casting. It was noticed, however, that in some of the annealed test bars which showed poor physical properties, the form of the temper carbon approached in places the flaky form of the graphite of gray iron. This was thought to be caused by too high an annealing temperature. To verify this, samples were heated at various temperatures with the results shown in Figs. 7, 8, 9, 10 and 11. These samples were from the original lot of metal cast from the same ladle. The form of the graphitic carbon is seen to change in an entirely gradual and continuous manner from the flake form of the gray

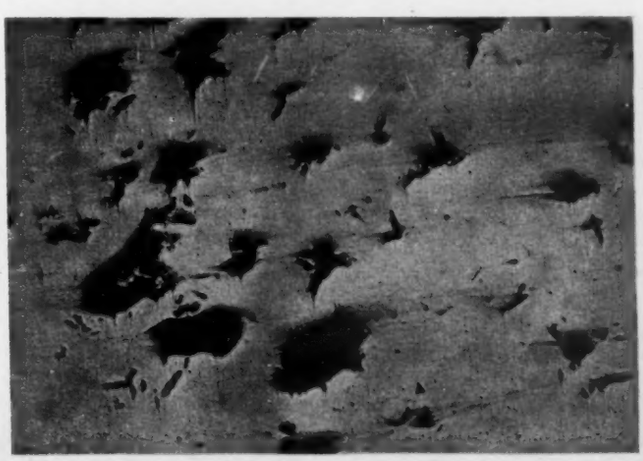


FIG. 10—MALLEABLE ANNEALED AT 1700 DEGREES FAHR., UNETCHED—MAGNIFIED 100 DIAMETERS

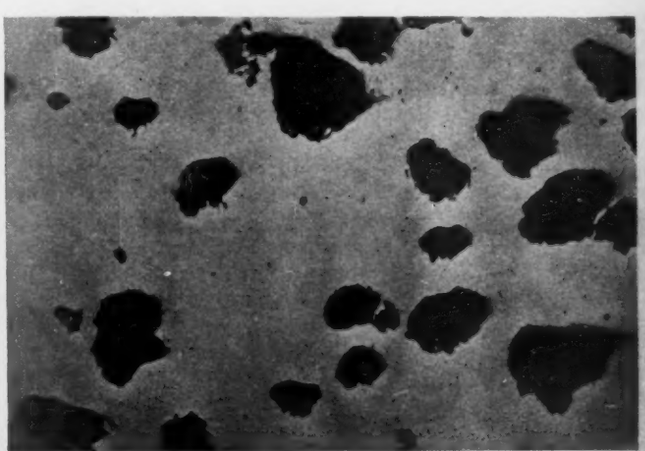


FIG. 11—MALLEABLE ANNEALED AT 1275 DEGREES FAHR., UNETCHED—MAGNIFIED 100 DIAMETERS

iron casting to the rounded form characteristic of good malleable. It is clear that the physical properties of annealed castings will likewise vary continuously from those of a gray iron casting to those of good malleable, according to the annealing temperature. The danger from high annealing temperatures, then, has a real metallurgical foundation, quite aside from the difficulties incidental to annealing room practice. The upper limiting temperature to be used in annealing, of course, is not sharply defined. It will vary, for a given white iron, according to the physical properties desired in the finished malleable iron.

The possibilities in the way of annealing treatments carried out in small laboratory furnaces are almost unlimited. Malleable castings can be produced of any desired quality consistent with the composition and quality of the original hard iron. The annealing time can be varied, as has been shown, from eight hours to eight days, the shorter time resulting in general in an inferior malleable. The anneal of eight hours probably can be even further reduced and still produce a casting in which the combined carbon is completely eliminated. It is also possible considerably to shorten the usual annealing periods and at the same time produce the highest quality of malleable, by processes involving comparatively rapid temperature changes. The authors have not, however, devoted much attention to such processes, because of their commercial impracticability. It has been considered that the annealing of malleable castings is necessarily a tonnage proposition, and that annealing treatments must be fairly simple, involving slow changes of temperature. Therefore, it has been attempted to apply the results of these experiments to the usual commercial practice.

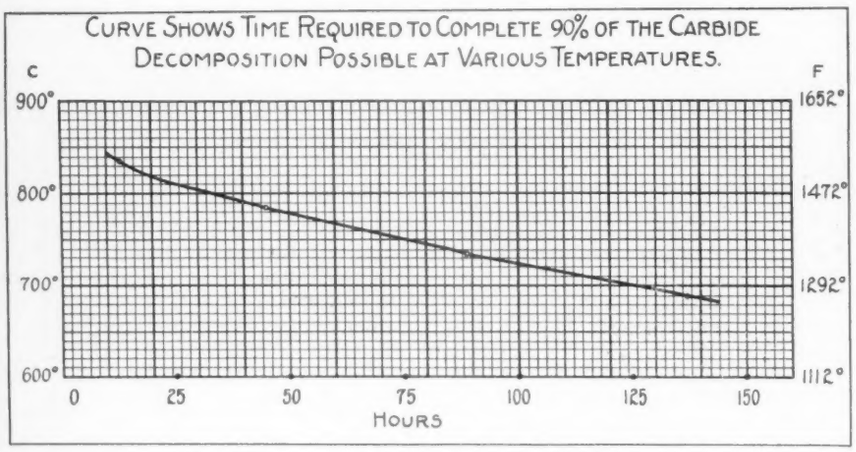


FIG. 12—RATE OF ANNEALING MALLEABLE IRON CASTINGS

Annealing treatments may be divided into two general classes: Those conducted entirely below the critical temperature, and those in which the critical temperature is at some time exceeded.

The first type is simple. The white iron castings are heated to a temperature between 1250 and 1375 degrees Fahr., and held at that temperature until annealing is complete. The time necessary to hold at heat depends upon the exact temperature and the nature of the original hard iron. The curve, Fig. 12, indicates the time required at various temperatures for the particular grade of iron used. It is evident that the rates of heating and cooling are without any metallurgical effect, and depend only upon the practical considerations of the annealing room. This type of treatment is the slowest, and may be expected to produce castings whose physical properties are as good as can be made from the same white iron by any other process. The one exception to this statement that occurs to the authors is in connection with hard spots, referred to later.

The second type of treatment, that is, in which the critical temperature is at some time exceeded, has many more variations. These must all have one feature in common. After cooling below the critical temperature, the castings must be held immediately below that temperature long enough to convert about 0.70 per cent of combined carbon to graphitic carbon. This, of course, is accomplished by cooling slowly to about 1250 degrees Fahr., or lower. The most rapid rate of cooling possible for a given casting will depend somewhat upon the temperature at which it is withdrawn from the furnace, that is, the slow cooling merely affords an opportunity for a reaction to take place which occurs at all temperatures between the critical and about 1250 degrees Fahr., with appreciable rapidity. It is evident that the higher the temperature at which the furnace is opened, the slower must be the cooling before opening.

On the other hand, the much discussed question as to the highest temperature at which a furnace can be opened without producing hard casting depends on the rate of cooling preceding. Theoretically, the casting might be withdrawn at 10 degrees below the critical, provided it had been held in that 10-degree range for some four or five hours. Such temperature control, of course, is impracticable in commercial work. Close attention to pyrometer equipment is required to measure temperatures within 10 degrees Fahr., and the temperature variations in a large oven may easily be 50 degrees Fahr. under practical operation.

Therefore, it is true, that even in a well controlled oven, the temperatures of the various castings may differ 60 degrees Fahr. from the reading indicated by the pyrometer. In some ovens this divergence rises to 200 degrees Fahr. Hence no definite temperature for opening the oven can be set, even when the rate of cooling is fixed. In general, it may be said that it is safe, for the grade of iron here considered, to cool at a rate of 15 degrees Fahr. per hour from the critical temperature down to 1260 degrees Fahr. minus the greatest possible divergence of actual temperature from indicated temperature. Thus, if this divergence is held to 60 degrees Fahr., the furnace can be opened at a temperature of 1200 degrees Fahr., as indicated by the pyrometer.

Bringing Castings Up to Heat

Returning now to the first part of the annealing process, let us consider the rate of bringing up to heat. This stage of the process, up to the critical temperature, is identical with the corresponding stage of processes of the first type, that is, in which the annealing is conducted entirely below the critical temperature. The temper carbon produced is of the well rounded form conducive to the highest physical properties.

Let us suppose that the heating has been so slow that only about 0.75 per cent of combined carbon is left by the time the critical temperature is reached. On passing through and above the critical temperature, no further formation of temper carbon will take place, and, presumably, the properties of the casting will not be injured unless the temperature becomes excessively high. Then, on cooling slowly through the critical, this remaining combined carbon will be converted to graphitic carbon.

Two things are gained by raising the temperature above the critical. First, the elimination of this remaining 0.75 per cent of combined carbon is accomplished in a much shorter time than if the annealing is completed below critical. It was found that to

eliminate the last 0.75 per cent of combined carbon when annealing entirely below critical required two to three days, whereas the same amount could be converted to graphitic carbon by slow cooling from above critical in five to seven hours. The second advantage of heating above critical is that hard spots such as caused by segregation of manganese or sulphur, are broken down much more readily than at the lower temperatures, thus reducing one of the consumer's greatest troubles.

The process just described and discussed may be said to produce malleable quite as good as that produced by annealing at a low temperature, and with a considerable saving in time. Any other annealing treatment of the second type may be considered as an inferior variation of this one. Thus, the period of bringing up to the critical temperature may be so short as to leave, say 2 per cent of the carbon in the combined form. On heating above the critical, about 1 per cent of temper carbon is then produced, of a form which is more injurious to the properties of the casting as the temperature of formation is higher. Time is saved by the use of higher temperatures, but at the expense of quality.

In conclusion, the authors wish to say that they do not believe that there is any such thing as an ideal heating cycle for the annealing of malleable castings. The best treatment to use in any particular case must depend on local conditions and on the purpose for which the malleable is produced. For example, in many cases machinability is more important than a high percentage of elongation. If so, a high temperature may be used to advantage. Each case must be considered individually.

Death of Major Joseph T. Speer

(*Concluded from Page 60*)

major. He resigned from the service in 1888.

Until the time of his death, Major Speer took an active interest in the affairs of the American Foundrymen's association. He was vice president from 1908 to 1909 and at the Pittsburgh meeting in 1911 he was elected president, having served two terms, namely 1911 and 1912. When he retired from the office of president, he was elected an honorary member of the association. He also was active in the affairs of the Pittsburgh Foundrymen's association and served two terms as its president. For many years he was a member of the Trinity Protestant Episcopal church in Pittsburgh and of the Pittsburgh chamber of commerce. Major Speer was married in early life, but his wife died in 1886.

German Iron Founders' Difficulties

The difficulties with which German iron founders have to contend, and which result in a constant deterioration of the quality of the iron produced, are likely to be continued for some time—possibly some years—after the war. The origin of these difficulties lies in the scarcity of pig iron, the shortage of labor, obstacles to the fulfilment of the conditions of furnace coke manufacture, and hindrances to transport. All these have of late been constantly increasing, and the conclusion of the war offers no immediate prospect of improvement. As a consequence of these unfavorable circumstances, recourse is had to scrap iron, large quantities of which have been brought from Belgium and the occupied districts of France. Hence there has been a growing deficiency in the silicon content of the iron. But these sources of scrap will henceforth be unavailable. Moreover, the inferior coke now being made introduces an excessive proportion of sulphur into the iron. It seems, therefore, that the quality of German iron must be low for some time to come, a fact that will militate against their hoped-for expansion of trade with Russia. The question of silicon in German iron, which now constitutes a difficult problem for the great Rhineland industry, makes interesting by its suggestiveness a method of procedure in the cupola furnace recommended by a writer in *Giesserei-Zeitung*. He recommends, as the teaching of his own experience, the use of prepared high-percentage ferrosilicon as a substitute for the low-percentage blast-furnace ferrosilicon commonly used as an addition to the cupola charge. These pig forms of added material are cast in sand 10 x 10 centimeters in section. They are cast with as much as 45 per cent ferrosilicon in nut size pieces, as is required to bring the content up to 10 per cent. This preparation is then used in the same way as the ordinary ferrosilicon addition.

Magnesite Mined in 1918

Statistics gathered by the United States geological survey place the approximate production of magnesite in 1918 at 225,000 tons. The entire output of this country comes from the states of California and Washington. During the first nine months of last year, California produced 69,500 tons and Washington, 90,500 tons.

California magnesite was in large demand in the eastern states in 1917 for use as refractory material, especially in making steel, but a combination of circumstances has greatly lessened the demand in 1918. In the first place crystalline magnesite from Washington, which is accounted superior to California magnesite as a refractory material, was sent to the market in increasingly large quantities in 1917 and its output was maintained in 1918; second, an increase in freight rates and a shortage of cars reduced the demand and hindered deliveries; third, dead-burned dolomite was with fair success substituted for magnesite for making refractory products in the eastern states.

Practically all the magnesite produced in Washington goes in the dead-burned form to steel plants and to manufacturers of refractory products east of the Mississippi.

Large Briquetting Plant Installed

The General Briquetting Co., New York, is installing a demonstration and custom briquetting plant at Fifty-seventh street and Twelfth avenue, that city. This plant has been designed to demonstrate, on a commercial scale, methods of briquetting metal, coal, flue dust, concentrates and other fine materials. This installation includes a 325-ton hydraulic metal briquetting press adaptable to steel, brass, aluminum or other metal scrap; Belgian roll coal briquetting machinery, rotary toggle press, masticators, annealing ovens, driers, elevators, conveyor system and a power plant. It is contemplated that operations will begin about Feb. 1, and the cost of the plant is estimated at $200,000.

Asks for Foundry Equipment Information

Lewis T. Kline, Alpena, Mich., manufacturer of baling presses, hand lathes, etc., is considering the erection of a foundry and is desirous of securing information regarding equipment for a modern casting plant. Plans for the shop have not yet been made. Mr. Kline is in the market for a steel frame building, 240 to 260 feet long, to be commanded by a 5-ton traveling crane, 40-foot span from center to center, and with 6-foot clearance at each end of the crane beam. He recently purchased about 700 feet of water front property, adjoining the Grand Trunk railroad at Port Huron, Mich., for the erection of a foundry.

The Malleable Iron Fittings Co., Branford, Conn., has completed the installation of an open-hearth steel furnace for producing steel for casting purposes. This melting equipment will greatly aid in increasing the output of steel flanged and screwed fittings.

Casting Tools From an Air-Hardening Steel

New Alloy is Used Successfully in the Manufacture of Dies and Forming Tools Without Forging — Tungsten is Not Present in the Metal

ROLLING, pressing or forging, long has been considered necessary in the production of cutting tools, shearing blades and dies of various types. Density and toughness required in these tools have been thought to preclude casting as a method of forming the finished articles. It is only within the past few years that attention has been directed to steel alloys which may be cast, finished and hardened without the assistance of the kneading or rolling operations.

Recently, in Cleveland, experimental work has been carried on, and now production is under way at the plant of the Cuyahoga Crucible Steel Co. on cast steel milling cutters, dies, shearing blades and forming tools. This company is using an alloy of chromium and cobalt steel, patented by a firm in Sheffield, Eng. The raw material is supplied by the Latrobe Electric Steel Co., Latrobe, Pa. Casting this alloy commercially presents a multitude of problems, in addition to those common in foundry practice.

Production tools and dies primarily require hardness and strength. Those minute cracks, blowholes, or blisters which might be permitted in steel castings intended for machine parts, cannot be tolerated in tools. Furthermore, stresses set up in hardening bring a decided weakening factor to bear, which forged steel has been thought to be best suited to resist. Even the cooling stresses within the mold constitute a factor which requires the most careful foundry practice.

The Cuyahoga Crucible Foundry Co., at present has only a small plant, including a five-hole, gas-fired crucible furnace, drying ovens, annealing furnace and necessary auxiliary equipment. However credible production is attained as a melt is made in 2½ hours when the furnace is hot. Domestic clay crucibles with a capacity of 100 pounds are used. Gas is supplied from two burners set into the side of the furnaces in such a manner that a swirling flame is induced around the single pot in each furnace hole. The average crucible is serviceable for four heats under a maximum melting heat of 2850 degrees Fahr. encountered in preparing this metal.

Preparing the Molds

The molds are prepared with particular care. They are hand-rammed from a good quality of molding sand in a metal flask, shown in Fig. 2. A liberal silica wash is applied to the face of the mold and if the size permits, the entire mold is dried in a core oven. In larger molds, the surface is skin-dried with a torch before it is closed. Every surface of each casting is chilled by the plentiful use of large headed nails.

The molding, pouring and shaking-out are performed with laboratory case, to assure against preventable casting strains. All castings are liberally gated, and the gates and surrounding surfaces are uncovered as quickly as the metal solidifies to prevent what is termed a *hot break* between the gate and the casting. Scrap losses assume serious proportions in this class of work, as gates, risers and defective castings cannot be remelted except for use in dies which do not have sharp edges. Gates from milling cutters may not again be melted for the same class of work, but can be used in rolls or forming dies. The explanation offered is that a structural change in the metal unfits it for the extreme stresses encountered in cutting operations. The chill nails, gates and risers are broken from the castings by hand after cooling.

The castings are covered with silica sand in a closed muffle and thoroughly annealed before finishing. It is stated that dies made from this alloy may be finished to final measurements before they are hardened. The company cites a 13½-inch blanking die which showed a variance of less than 0.002 inch after hardening.

Air-hardening is another property which it is stated, renders this alloy unique. All steels may roughly be considered as air-hardened; that is they are self-hard in a degree which depends upon the rate at which the carbide element separates from solution as the steel cools. The castings that this company makes are entirely hardened by an air-hardening process. They are heated slowly in an electrically-heated salt bath to 1832 de-

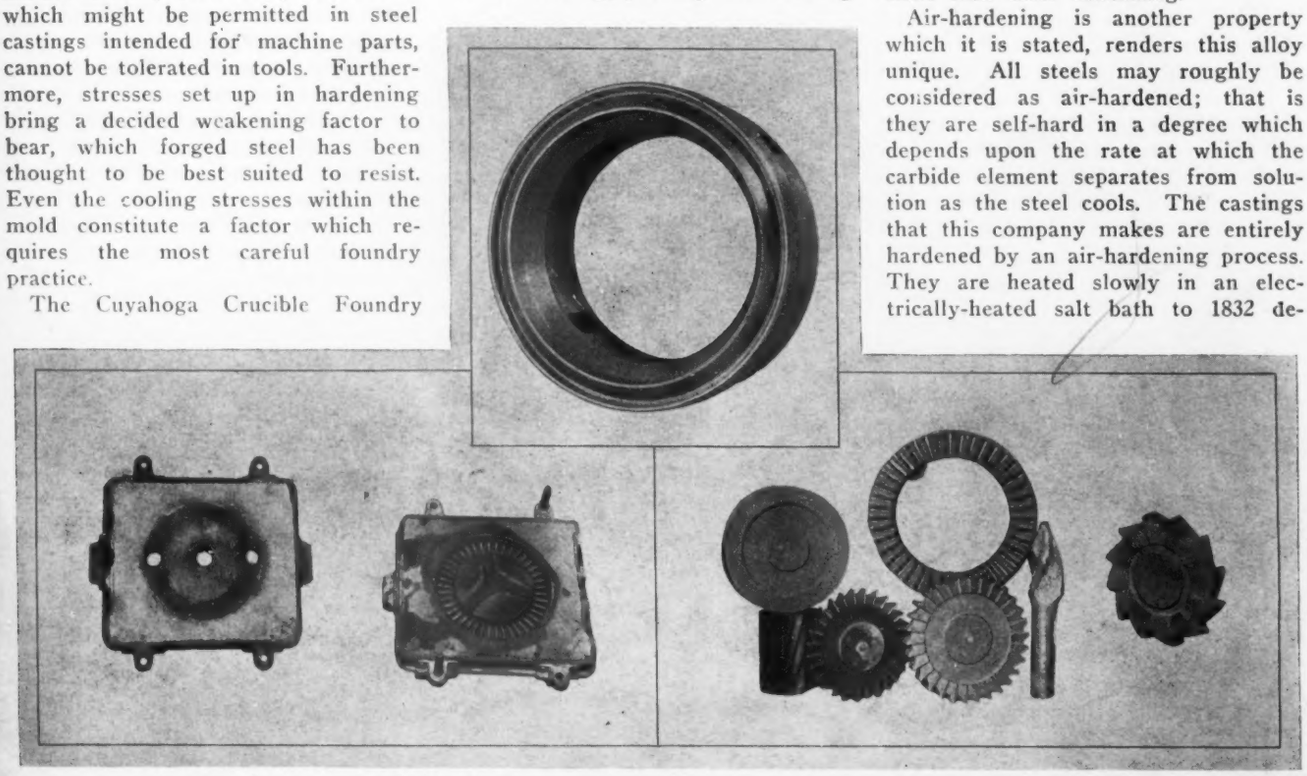
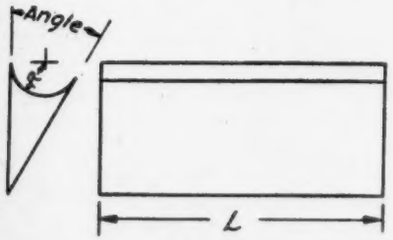


FIG. 1—THIS DIE FOR FORMING TOPS FOR SYRUP CANS, INDICATES THE FINE GRAIN AND MACHINING TEXTURE OF THE ALLOY FIG. 2—LIBERAL GATES AND RISERS ARE ALLOWED IN MAKING TOOLS BY THIS PROCESS FIG. 3—GEAR BLANKS, REAMERS, GEARS, COUNTER-SINKS, AND MILLING CUTTERS ALL ARE CAST SUCCESSFULLY

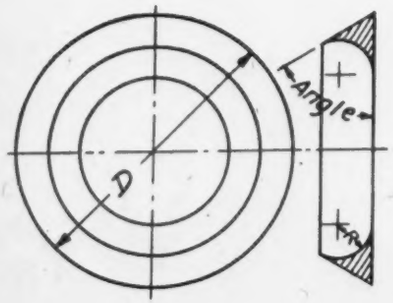
WEIGHT OF FILLETS

By W. L. Tryon



To find the weight of a straight fillet, multiply the radius squared by the length by the constant *C*, corresponding to the angle and material used. See Data Sheet No. 276. The formula for finding the weight follows:

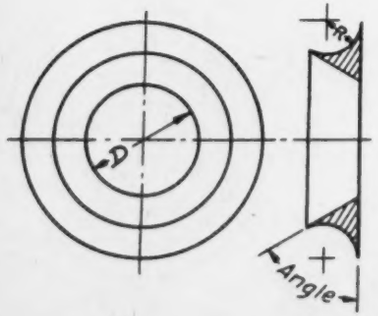
$$W = R^2 \; L \; C.$$



To find the weight of an inside circular fillet, multiply the difference between the diameter of the circle made by vertex and the product of the radius and the constant *K*, by the radius squared, by the constant *M*.

For constants *K* and *M* corresponding to the angle and material used, see Data Sheet No. 276. The formula for finding the weight follows:

$$W = (D - RK) \; R^2 \; M.$$



To find the weight of an outside circular fillet, multiply the sum of the diameter of a circle made by the vertex and the product of the radius and the constant *K*, by the radius squared, by the constant *M*.

For constants *K* and *M* corresponding to the angle and material used, see Data Sheet No. 276. The formula for finding the weight follows:

$$W = (D + R \; K) \; R^2 M.$$

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

WEIGHT OF FILLETS

By W. L. Tryon

(Continued from Data Sheet No. 275)

For fillets with an angle of 90 degrees use the following Data Sheets:

Straight fillets, Data Sheet No. 129.

Circular fillets, Data Sheet No. 163.

The following tables are for use with the formulas given in Data Sheet No. 275.

Material	Values of *C* When Angle of Fillet is									
	15 Deg.	22½ Deg.	30 Deg.	45 Deg.	60 Deg.	75 Deg.	105 Deg.	120 Deg.	135 Deg.	150 Deg.
Cast iron	1.605	.950	.632	.322	.1785	.1009	.0294	.0140	.0056	.0016
Cast steel	1.745	1.003	.686	.350	.1940	.1094	.0319	.0152	.0061	.0017
Aluminum	.595	.352	.234	.119	.0662	.0384	.0118	.0051	.0021	.0006
Copper	1.975	1.168	.777	.396	.2195	.1240	.0362	.0172	.0069	.0019
Zinc	1.560	.921	.624	.313	.1735	.0976	.0286	.0136	.0054	.0015
Gun metal	1.951	1.155	.768	.392	.2170	.1225	.0356	.0170	.0068	.0019
Yellow Brass ...	1.875	1.118	.739	.376	.2085	.1178	.0344	.0164	.0064	.0018

Material	Values of *K* When Angle of Fillet is									
	15 Deg.	22½ Deg.	30 Deg.	45 Deg.	60 Deg.	75 Deg.	105 Deg.	120 Deg.	135 Deg.	150 Deg.
For any material.	9.08	5.70	3.90	2.16	1.32	.750	.250	.225	.050	.020

Material	Values of *M* When Angle of Fillet is									
	15 Deg.	22½ Deg.	30 Deg.	45 Deg.	60 Deg.	75 Deg.	105 Deg.	120 Deg.	135 Deg.	150 Deg.
Cast iron	5.04	2.99	1.98	1.012	.561	.317	.0925	.0440	.0176	.0050
Cast steel	5.46	3.25	2.16	1.100	.610	.344	.1005	.0478	.0191	.0054
Aluminum	1.87	1.11	.735	.386	.208	.118	.0343	.0163	.0065	.0019
Copper	6.20	3.66	2.44	1.245	.691	.390	.1138	.0541	.0216	.0062
Zinc	4.89	2.91	1.94	.982	.545	.308	.0899	.0427	.0171	.0049
Gun metal	6.12	3.64	2.41	1.238	.684	.386	.1128	.0535	.0214	.0061
Yellow brass	5.89	3.49	2.31	1.185	.646	.370	.1008	.0514	.0205	.0058

FOR MATERIALS NOT GIVEN IN ABOVE TABLE,
C=WEIGHT PER CUBIC INCH MULTIPLIED BY k.
M=WEIGHT PER CUBIC INCH MULTIPLIED BY m.

Angle	15 Deg.	22½ Deg.	30 Deg.	45 Deg.	60 Deg.	75 Deg.	105 Deg.	120 Deg.	135 Deg.	150 Deg.
k	6.156	3.653	2.423	1.236	.6848	.3869	.1128	.0538	.0215	.0062
m	19.33	11.48	7.61	3.882	2.151	1.215	.3544	.1690	.0675	.0195

THE FOUNDRY DATA SHEET, FEBRUARY, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

grees Fahr. and are held at this temperature for five minutes. The temperature is then allowed to drop to 1787 degrees and the castings are allowed to cool in still air. Tools which have to withstand severe shock are heated to 1652 degrees and cooled to 1607 degrees Fahr. in the same manner.

In making milling cutters from 1/16 to 1/8-inch is allowed for finish in the rough casting, and the tools are machined to within a narrow tolerance before heat treating. Final finish however, is attained by grinding as in the case of high-speed steels. The absence of shrinkage in hardening makes it possible to make larger dies in one piece which formerly required a number of separate sections.

The alloy used is based upon cobalt and chromium, both metals native to the American continent. The absence of tungsten in the metal is stated to have no effect upon the density of the alloy. The specific gravity in fact, is said to be 10 per cent less than tungsten steel. The readiness with which the material hardens without fracturing in the sharp corners of castings is no doubt due in a great measure to the presence of the chromium. The fine grain is apparent in the die, Fig. 1.

Long life is claimed for tools cast from this metal. A die is reported from which 200,000 shell forgings were drawn without reworking. Blanking and forming dies made by this process have shown exceptional wear in blanking and drawing sheet metal parts for stoves and cans. Dies for forming corrugated paper boxes and shears for cutting cold steel bars are other products of this foundry. Milling cutters made from the alloy have successfully met comparison with other steels, and their service on bronzes and yellow metal is reported to be exceptional under service comparison.

Another Simple Foundry Cost System

By Andrew N Petersen

SIMPLE foundrymen do not need a simple cost system, for nothing can beat the good old-fashioned way of figuring castings for simplicity. For example:

Customer:—"What will you make 100 castings like this for?"
Foundryman:—"Oh! let me see, 7 cents per pound."
Customer:—"I can get all I want for 6 cents per pound."
Foundryman:—"Well, I'll make them for 5½ cents per pound."
Customer:—"All right, go ahead, the job is yours."

You can't beat that for simplicity—saves brains and worry, and no bother keeping accounts. The man who made the first price has been in business for years, he ought to know what he is doing.

There are several reasons why you can beat the other fellow in price, you have a better plant, you have some cheap material on hand, you need the work, you need the money and you can easily find a few more reasons, so you ought to be able to beat him at least half a cent.

The fact that both of you have been turning out castings amounting to a great many tons per year, and the fact that at the end of so many years you have barely made a living should not worry you, for if you worry you might begin to think, and if you think—well, why waste energy thinking when you have such a beautiful simplified simple system of foundry costs?

Prof. William W. Bird, of Worcester Polytechnic Institute, presented a paper on foundry costs at the June meeting of the American Society of Mechanical Engineers. This paper, published in the June, 1918, issue of THE FOUNDRY, has been commented on by several, and criticised by some, without offering a real substitute.

This paper may have been simple for a college professor or the traditional Philadelphia lawyer, but for a so-called "hard-headed, practical foundryman" some system must be used that is almost as simple as the old-fashioned simplified system referred to. Therefore, I substitute the following:

To estimate the cost of a casting plus the profit which is the selling price you must first know:

Cost of material at spout.
Producing labor.
Overhead.
Total cost.
Profit.
Selling price.

The cost of material at the spout includes the following items:

Tons of pig iron.
Tons of scrap iron.
Tons of coke.
Carting and freight on raw material.
Paid to helpers.
Paid to melters.
Per cent of loss in melting.
Incidentals.
Total.

The foregoing total divided by the number of pounds melted will equal the cost per pound. Overhead should not be included in this item. I consider 3 cents per pound for cost of metal at the spout to be right at this time in my locality, so will use that figure for illustration. The next item is productive labor and includes the following:

1. Floor molders, floor helpers. 2. Bench molders. 3. Chippers. 4. Coremakers.

The overhead should include the following:

Rent.
Power.
Heat.
Light.
Telephone.
Repairs and maintenance.
Taxes.
Insurance—fire and liability.
Office salaries.
General labor (everything except productive labor).
Office supplies.
Interest and discount.
Carfare.
General expense.
Freight and express (outside of raw materials).
Trucking.
Foundry supplies, such as sand, sea coal, fire clay, riddles, flour shovels and all material used in the foundry.
Merchandise allowances.
Loss of castings.

If account is kept of the foregoing items it will be found that overhead about equals the productive labor. Therefore, if we take the number of pounds produced and multiply it by three, this will give the cost of material; then add the amount of labor and add 100 per cent of what it cost to produce for overhead; add these three figures together and you have the cost; then add your profit and you have the selling price.

The following examples will explain this clearly:

Example No. 1

Figured weight, 100 pounds.
Estimated number that can be produced per day by molder and helper, five.
Cores, none.
Extra chipping, none.

500 pounds at 3 cents	$15.00
Molder and helper	10.50
Overhead, 100 per cent of productive labor	10.50
Total cost	36.00
Profit, 10 per cent	3.60
	$39.60

Selling price, 500 pounds at 8 cents, equals $40.

Example No. 2

Figured weight, 100 pounds.
Estimated number that can be produced per day by molder and helper, five.
Cores, three hours.
Extra chipping, none.

500 pounds at 3 cents	$15.00
Productive labor:	
Molder and helper	10.50
Cores, three hours at 60 cents.	1.80
Overhead 100 per cent of productive labor	12.30
Total cost	39.60
Profit, 10 per cent	3.96
	$43.56

Selling price, 500 pounds at 8¾ cents, equals $43.75.

Example No. 3

500 pounds at 3 cents	$15.00
Productive labor:	
Molder and helper	10.50
Coremaker, three hours	1.80
Chippers, five hours	3.00
Overhead, 100 per cent of productive labor	15.30
Total cost	45.60
Profit, 10 per cent	4.56
	$50.16

Selling price, 500 pounds at 10 cents, equals $50.00.

Example No. 4

Weight of casting, 10 pounds.
Number made per day by bench molder, 50.

500 pounds at 3 cents	$15.00
Bench molder, productive labor	6.00
Overhead	6.00
Total cost	27.00
Profit, 10 per cent	2.70
	$29.70

Selling price, 500 pounds at 6 cents, equals $30.

Example No. 5

500 pounds at 3 cents	$15.00
Productive labor:	
Bench molder	6.00
Coremaker	6.00
Overhead	12.00
Total cost	39.00
Profit, 10 per cent	3.90
	$42.90

Selling price, 500 pounds at 8½ cents, equals $42.50.

The foregoing examples show that it is possible to make a scale of selling prices that can be used by any foundryman who can estimate the number of castings that can be produced by a molder per day. The scales of selling prices in Tables I and II have been developed for floor molders and helpers and bench molders. All special work that includes cores or extra chipping must be figured as shown in the examples Nos. 2, 3 and 5.

TABLE I.

FLOOR MOLDERS AND HELPERS.

Pounds.	Cents per pound.	Total.
150	18¾	$28.05
200	14⅞	29.70
250	12½	31.35
300	11	33.00
350	9⅞	34.65
400	9	36.00
450	8½	37.95
500	8	40.00
550	7½	41.25
600	7⅛	42.75
650	6⅞	44.55
700	6⅝	46.20
800	6⅛	49.00
900	5⅞	52.80
1000	5⅝	56.10
1200	5¼	62.70
1500	4⅞	72.60
2000	4½	90.00
2500	4¼	106.25
3000	4⅛	122.10
3500	4	140.00
4000	3⅞	155.10
5000	3¾	187.50

TABLE II.

BENCH MOLDERS.

Pounds.	Cents per pound.	Total.
50	30⅞	$15.40
75	21⅝	16.22
100	17	17.00
125	14¼	17.87
150	12½	18.70
175	11⅛	19.52
200	10⅛	20.35
225	9½	21.17
250	8⅞	22.00
275	8⅜	22.82
300	7⅞	23.65
325	7½	24.47
350	7¼	25.30
375	7	26.25
400	6¾	26.95
425	6½	27.77
450	6⅜	28.60
475	6¼	29.42
500	6	30.00
550	5⅞	31.90
600	5⅝	33.55
700	5¼	36.85
800	5	40.00
900	4⅞	43.45
1000	4⅝	46.75

To use this scale in checking up work, take any floor, figure or weigh the amount of work produced per day and you will find on the list what you ought to receive for it. This list, of course, would change in the different localities, as labor conditions are different, but if each locality could agree on a scale, it would stop all cut-throat practices, but it would not stop competition, as the production would govern the prices; some foundries can produce certain work better than others, consequently one foundry can beat the price of another without losing money, which is the main object of this system.

For example, if a molder and a helper in one foundry can produce five castings weighing 100 pounds each, they would have to charge 8 cents per pound, and another foundry can produce six castings from the same pattern with the same labor the charge for the same would be 7⅛ cents per pound. This is fair competition and the price is not cut by guesswork, but by production.

Six-Hour Molding Day Established in Stove Shops

Effective Jan. 1, the 6-hour molding day with the last ladle of iron to be delivered to the molders in 1¾ hours thereafter, was established in the shops of the Stove Founders' National Defense association by agreement with the International Molders' union. An advance of 10 30/37 per cent on the net earnings of all piece-workers in stove foundries also was granted and a minimum day wage rate of $5.75 for all day workers also was established. The 8-hour day for members of the International Molders' union employed in core rooms of stove shops also was adopted. The advance in net earnings of all piece-workers provides for the payment of 105 per cent board prices, for example, where the board price previously was 85 per cent.

The demands of the International Molders' union involved an increase of 25 per cent on the present earnings of all molders employed in the foundries of the members of the Stove Founders' National Defense association, whether employed in the molding or core room and regardless of the class of work produced. This increase would have amounted to 131.25 per cent on 1898 prices, or its equivalent. A minimum day wage rate of $6.50 also was asked for day workers. The demand for a 6-hour molding day with the last ladle of iron 1¾ hours after the 6-hour molding time, was granted, as well as the demand for an 8-hour day for core molders. In addition a demand was made that the firm shake-out castings, take out castings and trim them, wet the sand, heap and cut it free of charge. However, the latter demands were not granted. A demand also was made that 131¾ per cent or its equivalent, be paid on steam and hot water work, except cored work.

Core and Mold Drying Ovens Installed in Eastern Foundries

The Bradford-Ackermann Corp., 30 East 42nd street, New York, eastern representative of Young Brothers Co., Detroit, manufacturer of core and mold drying ovens, has made numerous large installations of these ovens in eastern foundries, as follows: Worthington Pump & Machinery Corp,. East Cambridge, Mass., one fuel oil, 4-compartment kiln oven and four fuel oil 2-compartment kiln ovens; Eastern Malleable Iron Co., Troy, N. Y., gas-heated drawer pull oven and three gas-heated 4-compartment kiln ovens; Wm. Cramp Sons & Co., Philadelphia, two fuel oil kiln ovens for its brass foundry; Taylor-Wharton Iron & Steel Co., High Bridge, N. J., electrically-heated drawer pull oven; Fairley-Davidson Steel Co., Brooklyn, fuel oil kiln mold baking oven; and the Connecticut Electric Steel Co., Hartford, Conn., electrically-heated drawer pull oven.

Increased Melting Capacity Aids Production

How Additional Labor, Working Through Three Eight-Hour Shifts, With the Aid of Larger Furnace Output Met an Emergency War Demand

ESTABLISHED a number of years ago for the production of a varied line of commercial castings, the Warren Steel Casting Co., St. Louis, rendered excellent service during the war on government work. Railway, automobile and agricultural steel castings made way for artillery tractor castings with little effect upon the foundry's procedure. The demand for 25,000 artillery tractors to replace 640,000 horses in dragging field guns and auxiliaries turned hundreds of foundries to this class of work. This company entered the field early and until the termination of the war was engaged to capacity in casting track links, grousers, sprocket and guide wheels, equalizers, and countless other parts for artillery tractors which usage demanded should be made of steel. Its expansion was effected by increasing the working force and by adding to the melting capacity.

For a number of years the Warren company has operated successfully a 4-ton, oil-fired, open-hearth furnace, installed by the McLain-Carter Furnace Co., Milwaukee. The molding capacity proved more than ample for the needs of this unit and a 1½-ton Heroult electric furnace was put in operation during 1916. These two units successfully met all demands until the pressure of war work led to the installation of a second Heroult furnace last year. These three melting mediums produced from 45 to 50 tons of steel per day all of which went into tractor castings for the ordnance department. The company places great stress upon the quality of its metal and the efficiency with which its furnaces are operated. Richard Davies, an experienced steel man, under the title of furnace superintendent, devotes his entire time to the three furnaces mentioned.

Tractor castings, produced for the ordnance department, were required to meet the following analysis: Carbon, 0.25 per cent; silicon, 0.25 per cent to 0.35 per cent; manganese, 0.65 per cent and sulphur, less than 0.05 per cent. Rigid control was exercised at all times by a chemical laboratory located on a mezzanine floor.

The open-hearth unit was driven to capacity during the pressure of ordnance work. The average time from charge to tap was only three hours, with heats in some instances made in about two hours. From 7500 to 8300 pounds constituted the normal weight charged in the open hearth. This charge consisted of 80 per cent foundry scrap, cut plate and shovel scrap and 20 per cent of low phosphorus, high silicon pig iron. Difficulty was experienced with the low grade of fuel oil obtainable under war conditions. The oil consumption was approximately 85 gallons per ton of metal refined with this unit. At the then prevailing price of oil this made the melting cost of the open hearth about $6.80 per ton. It is

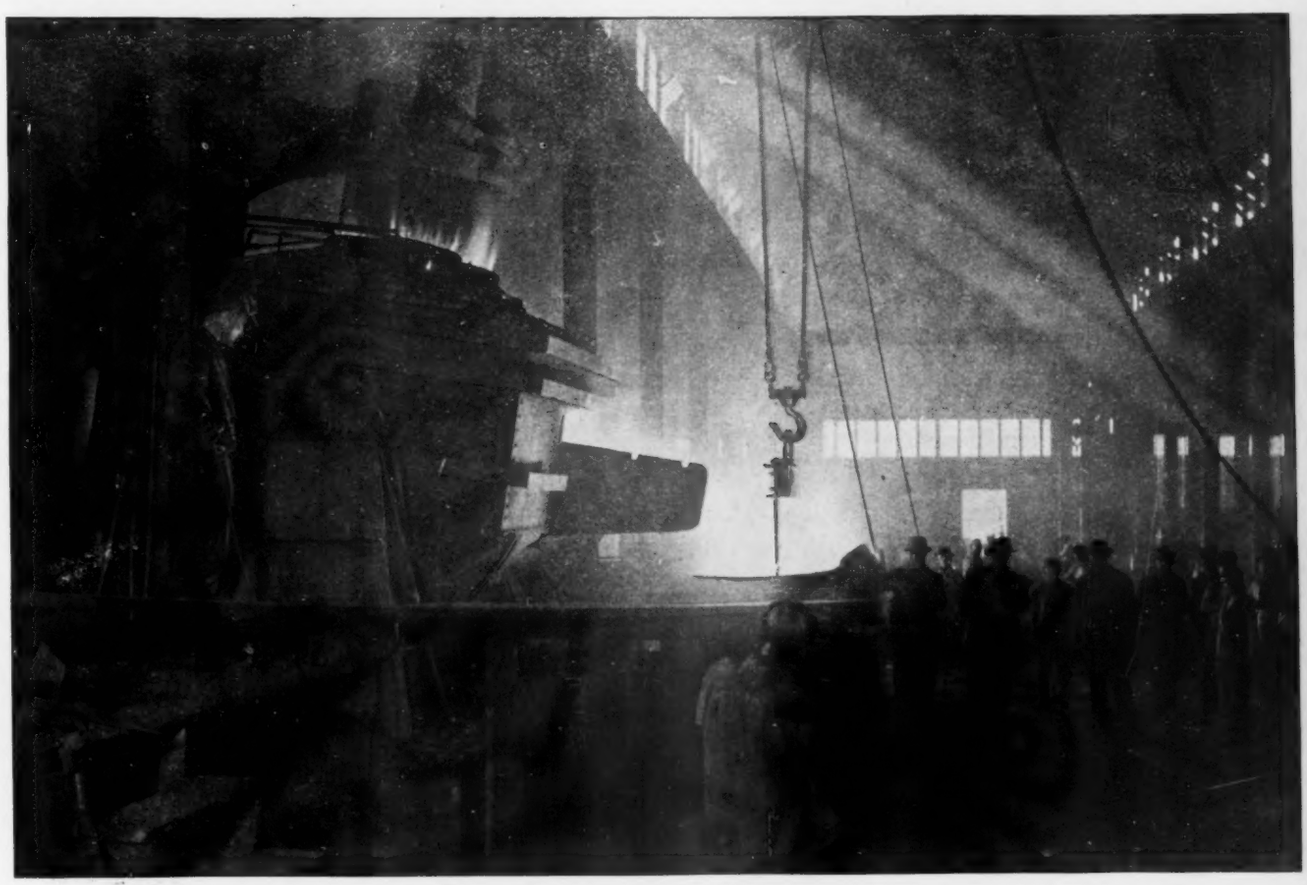


FIG. 1—ALTHOUGH HAND-FIRED AND HAND-CONTROLLED BOTH IN MELTING AND POURING, THIS ELECTRIC FURNACE ATTAINED ELEVEN 1½-TON HEATS IN 24 HOURS IN REFINING METAL FOR ARTILLERY TRACTOR PARTS

FIG. 2—GENERAL VIEW OF THE WARREN STEEL CASTING CO.'S FOUNDRY IN ST. LOUIS—THE CENTRAL BAY IS DEVOTED TO MOLDS FOR CASTINGS UP TO 300 POUNDS

stated that this cost might have been lowered with better oil. The wage cost under the company's system of accounting was distributed over all the melting units and averaged $9.78 per ton.

The first electric furnace installed, designated as No. 1, is illustrated in Fig. I. It is set on a concrete base with a ladle pit in front. Supporting tracks are provided upon which the two rockers at either side roll forward when the melt is poured. A system of gears operated through a large hand wheel serves to tilt the furnace for pouring. A charging door opens in the back, through which the scrap is charged by hand. The capacity of this unit is 1½ tons per charge.

The superintendent, experiencing difficulty in reducing the viscosity of the slag, made some structural changes in the interior plan of the furnace. He found that though the metal was sufficiently fluid, the slag added to the time required for melting and refining. To correct this he lowered the entire roof 8 inches, and substituted three 14-inch electrodes for the 12-inch carbons which had been in use. Over 250 heats were obtained even at the higher temperatures encountered before the roof required relining. The roof lining was 16 inches thick while the sides and bottom were lined to 13 inches from the shell. The pouring temperatures attained ranged from 2800 to 2900 degrees Fahr. for the class of work then handled.

The second Heroult furnace installed is similar to the first, except that its capacity is 5500 pounds of scrap. The electrodes used were 12-inch, but the 14-inch size are to be installed later. The electrodes in both units are fed by hand.

Both electric furnaces operate at 110 volts. Current is supplied by the Union Electric Co., St. Louis, and is stepped down by two 250-kilovolt-ampere transformers. The furnaces operate at 95 per cent power factor. The current consumption ran comparatively even, and averaged about 600 kilovolt-amperes per ton.

Speed-up Heats

The larger furnace handled nine heats of 5500 pounds each per 24 hours during the time when the company was pushing the government work. No. 1 furnace excelled this figure, and averaged 11 heats of 3000 pounds in the same period. The three units, that is, the open hearth, and the two electric furnaces produced 19 or 20 heats per 24 hours continuously when the need existed. This involved melting and refining 45 or 50 tons of metal each day. Averaging the output of several months, the foundry melted about 850 tons per month. The average current cost with the electric furnaces was $4.18 per ton.

The foundry which handled this output is not large It is contained within a single building, roughly 60 x 550 feet, with two side bays extending the entire length and about 30 feet wide. The open-hearth and No. 1 electric furnaces are at one side of the building, while No. 2 electric furnace is at the extreme end. The entire central portion was devoted to the larger castings, which in few cases exceed 300 pounds. These were hand-rammed on the floor where they

FIG. 3—LIGHT CASTINGS, SUCH AS THE TRACTOR GROUSER OR MUD HOOK, SHOWN ON THE MACHINE AT THE RIGHT, WERE MADE IN THE SIDE BAYS

were poured by a pouring gang.

One side bay was devoted to light castings, which during the war period consisted mainly of caterpillar links and grousers and other light tractor castings. Light combination jar squeezer machines, and a number of plain jolt machines, all made by the United States Molding Machine Co., Cleveland, occupy the side bay where the light castings were made. This company produced a large number of the track links for the 10-ton artillery tractor. Part of these were molded on machines, and part were rammed by hand on the floor to keep up with the demand. Some were molded in green sand entirely, others with more intricate sections were made with the use of cores, and a few were made almost entirely from cores. The grouser castings were all molded on the squeezer machines.

The core room is equipped with two machines made by the International Molding Machine Co., Chicago; five jar and squeeze machines constructed by the United States Molding Machine Co., Cleveland; four manufactured by the Federal Foundry Supply Co., Cleveland, and two core machines made by the Wm. Demmler & Bros., Kewanee, Ill.

Two sand-blast installations, built by the Pangborn Corp., Hagerstown, Md., and one by the Phoenix Machine Co., Inc., New York, were used to clean the castings. Two large and three small tumbling barrels, manufactured by the Illinois Mfg. & Supply Co., Quincy, Ill., six double-wheel stand grinders, and one swing grinder completed the cleaning room equipment including the chipping hammers and an oxyacetylene torch. The pneumatic tools were purchased from the Ingersoll-Rand Co., New York; Chicago Pneumatic Tool Co., Chicago and the Geo. Oldham & Son Co., Philadelphia.

A core oven, 15 x 20 feet, oil-fired and provided with three car type racks, gave barely sufficient capacity for the cores required on this work. A new building to extend this capacity was under consideration at the time of the armistice. The two large annealing ovens were also oil-fired. A duplex oil pump, and three air compressors, the latter with a capacity of 1150 cubic feet per minute, were housed in a leanto back of the open hearth. Compressed air was supplied to the molding and core machines, to pneumatic rammers on the main floor and to the two 10-ton air hoists used in handling the ladles from the various melting units.

Negro labor was employed in many of the departments of this foundry. The company employed 140 molders, 75 coremakers and over 300 laborers. The entire force was divided into three shifts.

C. A. Hayden is president of the company; Harry Benjamin, vice president; W. A. Kamerer, treasurer; Charles Vastine, secretary and J. P. Pero Jr., sales manager. C. W. Mueller is general superintendent.

FIG. 5—STEEL ENTERS PROMINENTLY INTO THE PARTS REQUIRED FOR THE TRACTION ELEMENTS OF MILITARY TRACTORS—GUIDE, ROLLER AND SPROCKET WHEELS, TRACK LINKS AND GROUSERS PREDOMINATED IN THE OUTPUT OF THIS FOUNDRY

FIG. 4—A LARGE PROPORTION OF THE FOUNDRY SCRAP WHICH WAS USED IN THE ELECTRIC FURNACE CHARGES WAS THOROUGHLY TUMBLED BEFORE IT WAS USED

Standard Factory Buildings to be Erected

The Austin Co., Cleveland, engineer and builder of standard factory structures, has been awarded a contract by the Air Reduction Co., New York, for the erection of five buildings at Boston, of the following dimensions: 40 x 100 feet, 27 x 62 feet, 12 x 28 feet and two buildings, 20 x 30 feet. The construction work is to be completed in 30 days. Also a contract has been received from the American Engineering Co., Philadelphia, for the erection of a building, 100 x 150 feet, to be completed in from 60 to 75 days. The National Analine & Chemical Co., Marcus Hook, Pa., has contracted for a bulding, 106 x 109 feet.

The Robeson Process Co., New York, announces the following changes among its representatives: At Birmingham, Ala., and Cincinnati it will be represented by the Hill-Brunner Foundry Supply Co., and at Chicago, Pittsburgh and St. Louis by the S. Obermayer Co. Brewer & Co. will represent the Robeson Process Co. at Worcester, Mass., and Providence, R. I.

The Application of Pyrometers to Core Ovens

The Author Points Out How the Demands of Modern Industry Have Developed Refinements in Coreroom and Foundry Practice

By G W Keller

IN the use of pyrometers for core and mold drying ovens there are a number of different methods of application to be considered. The first applications of pyrometers were made some 20 to 30 years ago, the instruments being of an older type. Some of these pyrometers are still in service as they are extremely rugged with no fragile glass parts to become broken. This older form of pyrometer is commonly known as the expansion pyrometer, as it operates on the difference in the expansion of metals. While it has not the degree of accuracy for measuring temperature of instruments of more recent development, it proved of sufficient value on account of its durability to warrant its use over a period of many years. More modern instruments, however, have gradually superseded this type, namely the electric indicating and recording pyrometers, and the gas-filled indicating and recording thermometers.

As a matter of interest it may be worth while to devote a few moments to the general construction of the older form of pyrometer as well as the later types. The first form

FIG. 1—CENTRAL STATION PYROMETER

of pyrometer, commonly known as the expansion pyrometer, operates through the difference in expansion of a graphite rod enclosed within a steel stem. A pointer is attached at the top and by means of a spring the change in expansion is exaggerated and the pointer swings around a circular dial as shown in Fig. 3. The scale on this instrument can be made quite open, as approximately 320 degrees out of a possible 360 is used for the circular scale.

However, the great disadvantage of this form of instrument is that the indicating or recording part must be connected to the steel stem. In the case of the electric pyrometer or gas-filled long-distance thermometer, the instruments may be located at a distance where it may be more convenient to observe them.

A pyrometer which may be extended to meet practically all conditions is the electric pyrometer using base metal thermocouples composed of wires properly protected with steel or iron sheaths. These thermocouples are usually about 3 feet long and are placed in each core oven, and several may be connected to one indicating instrument properly graduated to approximately 800 to 1000 degrees Fahr. The elasticity of this equipment can readily be noted, as by means of a switchboard with con-

A paper presented at the recent meeting of the American Foundrymen's association at Milwaukee. The author is connected with the Brown Instrument Co., Philadelphia.

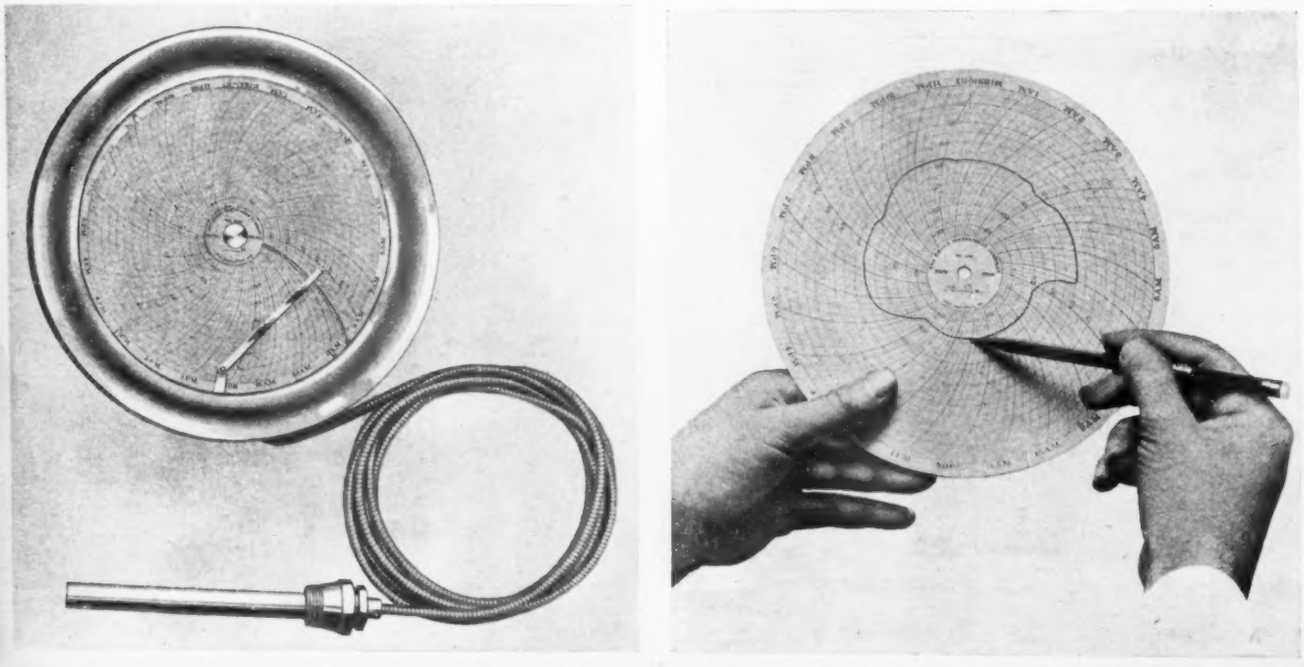


FIG. 2—RECORDING ARRANGEMENT OF GAS-FILLED RECORDING THERMOMETER AT THE LEFT—AT THE RIGHT, RECORD OF 24 HOURS' OPERATION

tacts, each one representing a thermocouple, any number of core ovens may be connected to a central station pyrometer, as shown in Fig. 1.

Thermocouples composed of two wires of slightly different alloy, welded at one end, generate a small electric current. This electric current is transmitted to the electric pyrometer by ordinary copper wire. The construction of the thermocouples is even more robust than in the expansion type of instrument. They are provided with an outer protecting sheath that does not form one of the elements. Direct oxidation or burning away of the thermocouple elements at moderate temperature is practically eliminated. The electric wiring is easy to string and will permit the instrument to be located where it may readily be observed by the core-oven tender.

Electric pyrometers have been in service for many years, particularly in malleable iron and steel annealing plants. This is probably due to the fact that at higher temperatures it has been the common belief that greater attention should be paid to the temperatures at which the metal should be annealed. Within the last two or three years, however, it has been recognized that in order to secure good castings, the proper attention must be given to making the molds and drying the cores. Instead of the crude brick core ovens such as can still be seen at the older iron foundries, more modern types of ovens are now used, many of which have been carefully designed for better combustion of the fuel. Large core ovens are still generally built of brick, though small core ovens are frequently composed of a brick lining with sheet metal covering. This presents a neat and finished appearance. Instead of the crude doors which allow the loss of heat at a great expense and wastage of fuel, modern core ovens have either a metal door which is raised by a counterweight, or is of the more modern roll types.

By carefully checking up the temperatures of the core ovens the foundryman anticipates any trouble in the castings which may occur due to green cores and eliminates questionable results due to changes in oven temperatures which formerly would not be observed by the oven tender. The drying of the cores can be placed on a more scientific basis.

It is natural that a large core should take more time than a small light core. The maximum temperature should not be exceeded, but the average length of drying must be carefully studied. At many plants they frequently fill the ovens with all dimensions and sizes of cores. As a result it is natural that if the oven is unloaded at the proper time for the light cores the heavier ones will still be green. In such instances the time element must be the average for the lot when they cannot be separated into sizes and dried.

Pyrometers take away from the oven tender the worry as to what his temperatures are. They also furnish the superintendent or manager with valuable data as to what temperatures are best for certain sizes of cores. In this respect the process is similar to the heat treatment of steel and other metals. Before the extensive use of pyrometers, the management depended entirely upon the skill of the hardener whether the results of heat treatment were properly secured. In the early days, the heat treatment of metals was not considered of such great importance as it is at the present time. The hardener usually either tested the steel with a magnet to determine its hardening point or merely guessed when the temperature reached the hardening point. He had no idea what the hardening point of the steel actually was. The critical or transformation points of steel were unknown quantities.

Since the component parts of automobiles, tractors, etc., depend considerably for their durability on the heat treatment they receive, more attention has been paid to this process and the responsibility largely taken away from the actual man who heat-treats and placed on the shoulders of the metallurgist, superintendent or some other specialist.

This same advance in efficiency is now under process in the foundry. Castings cannot be expected to stand the strain placed upon them unless they are properly made. Improvements in the manufacture of castings are fast being incorporated at many plants. At one time it was considered only necessary to brush the casting with a stiff wire brush. Since then sand blast has been used with better success. It is necessary to adopt improvements to keep pace with the other allied lines of the metal industry.

While the description above has covered more particularly the indicating type of pyrometer equipment, recording electric pyrometers are also frequently used and in fact a recording instrument adds considerably to the efficiency of the pyrometer equipment. Where there are a number of core or mold drying ovens, the recording long-distance thermometer of the gas-filled type is frequently used. It is necessary to use one instrument for each oven and where there are a number, it is slightly more expensive. Their installation should be given careful attention as, with a gas-filled bulb and copper tubing, care must be taken that this tubing is installed out of the way of trucks or injury from any cause. The tubing is protected with a flexible steel armor, but this can be injured if carelessly installed.

The gas-filled recording thermometer in its operation is based on the

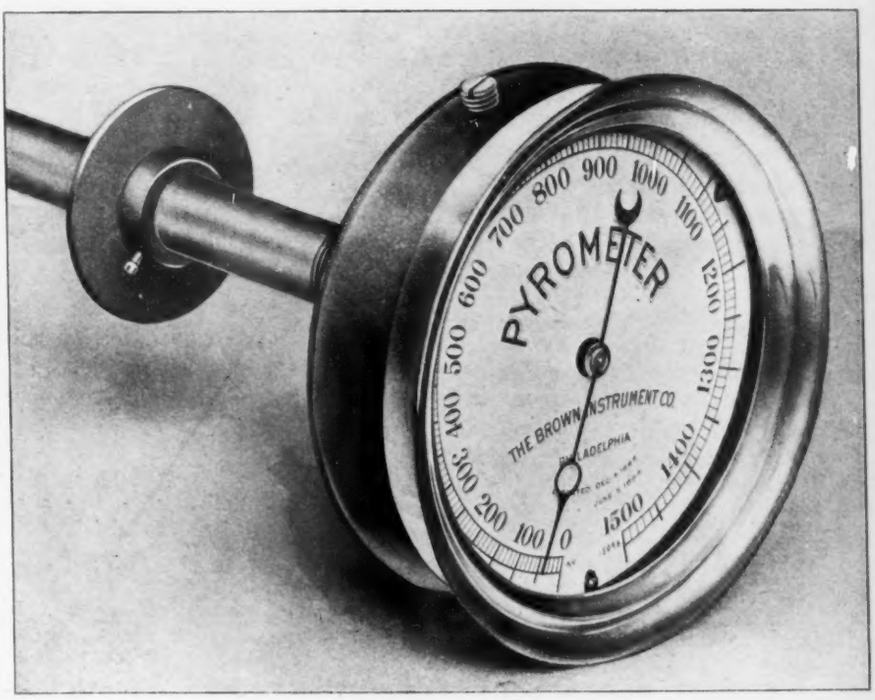


FIG. 3—OLDER FORM OF PYROMETER

principle of a nitrogen gas-filled bulb under pressure. This gas expands upon the insertion of the bulb into heat and the pressure thus exerted is carried to the recording instrument which may be attached at the side of the core oven or at any distance within approximately 100 feet of the bulb. A record is produced by a pen arm attached to a coiled helical tubing at the end of the steel armored tubing. This recording arm swings out over the scale, as shown at the left in Fig. 2.

At one plant where a large core drying oven and also an oil-fired mold-drying oven is operated, since the installation of recording thermometers, the man in charge especially at night, who is frequently only a watchman, properly attends to the ovens, so that the molds are not green nor burned. Recording thermometers will also safeguard the output as should there be any change of oven tenders due to sickness or other cause, there would be sufficient data on file to enable the continuance of the ovens without danger of loss.

The charts produced furnish a record for the entire 24 hours, as shown by the facsimile chart at the right of Fig. 2. Instructions may be given the night man so he can readily see from the previous temperature curve just what the oven has been doing from the start. This also serves the superintendent or manager as a check, as the records are usually handed in the next morning and at a glance the superintendent or manager can readily note whether the ovens have been properly fired. If the night man should fall asleep, naturally the record would clearly indicate this by a change or falling off in temperature.

Probably one of the most important advantages just at this time is the saving of fuel, whether it is coal, gas or oil. Even though a slight percentage of fuel be saved per day, it is one step in the right direction.

At one plant which recently changed management, th new manager who had previously used pyrometers on his malleable iron annealing ovens, immediately upon taking charge of the iron foundry, equipped his core ovens with recording thermometers. It evidently was one of the first improvements that received his attention, as he undoubtedly realized the importance in accurately controlling the temperatures of his annealing ovens, and the similar process of controlling his core oven temperatures though at a considerably lower temperature. Undoubtedly there will be vast improvements in the construction and application of pyrometers for this purpose in the future.

Automatic Temperature Control

The automatic control of the temperature in core ovens is quite possible where fired by gas or electricity. In fact, an automatic control pyrometer suitable for this purpose has already been developed. It is operated through electric switches or solenoid operated valves which partly open and close the electric circuit of the electric fired ovens or the flow of gas in gas fired ovens.

In developing such equipment together with other new types of temperature measuring apparatus, the pyrometer manufacturer greatly appreciates the co-operation of the user of such equipment. Practical demonstration of newly developed apparatus can be made much better when in actual service than in the laboratory of the pyrometer manufacturer. The advantage of this co-operation is probably more in favor of the user as he receives more direct benefit from the continued serviceof the practical pyrometer equipment.

As a brief summary of the more pronounced advantages in the use of temperature measuring apparatus, it would be well to consider the following:

First:—Eliminates guesswork as to the temperature inside the ovens.

Second:—Serves as a practical guide for the oven tender by which to gage the time period of core drying.

Third:—Lowers fuel consumption through maintenance of correct temperatures.

Fourth:—Serves as a check on the operation of the ovens and furnishes important information to the manager or superintendent.

Unquestionably the increased efficiency of plant operation in the future will include more careful control of core and drying oven temperatures along with other improvements. Co-operation between the manufacturer and instrument makers is to be hoped for now, more than ever before.

Abrasives for Grinding Malleable Castings

By W T Montague

THE importance of the malleable iron castings industry and the rapid expansion noted in recent years makes the subject of grinding malleable castings well worth considering. The anealed castings usually are ground on floor stands with ½ or 2-inch spindles. Occasionally, small castings are ground on bench stands mounting 10 or 12-inch diameter wheels, 1 to 1½ inches thick with a 1¼-inch hole. Also, some of the heavier types of castings are more conveniently ground by means of swing-frame grinding machines. In this case, 18 to 24-inch diameter wheels are used down to about 14 inches diameter, when they are transferred to floor stands for smaller castings and thus used down to about 8 inches diameter.

Sizes and Shapes of Wheels

In the majority of cases, straight wheels are used, but we find a few beveled wheels in service, tapered both sides, ½ to ¾ inch per foot. As it usually is possible to have the wheel guarded by a protection hood, there is no real reason for the use of the beveled wheel. Such wheels cost more to make and command a higher price than a straight-sided wheel of the same diameter. Also, in manufacture, they require a larger amount of abrasive material for a given diameter than straight-sided wheels and this extravagance seems useless, especially when there is a growing necessity for maximum conservation of the abrasive supply of the country. The following sizes are considered good practice for use on floor stands.

Diameter, inches	Thickness, inches	Arbor, hole, in.
14	1½, 2, ...	1½
16	1½, 2, 2½	1½
18	2, 2½, 3	1¼
20	2, 2½, 3	2
24	2, 2½, 3	2

The surface, at least, of malleable iron castings is essentially a low-carbon steel and it has similar physical properties. Therefore, this automatically determines that the proper abrasive is alundum or some other aluminous abrasive.

The following three types of alun-

Adapted from an article in a recent issue of Grits and Grinds, published by the Norton Co., Worcester, Mass., with which the author is connected.

dum vitrified grinding wheels are most generally specified for use on annealed malleable iron castings: For small automobile parts and miscellaneous castings up to 5 pounds in weight, 24 grit, *Q* grade; for miscellaneous castings from 5 to 25 pounds, 20 grit, *R* grade; for larger castings and any castings with sharp fins and narrow edges, 20 grit, *S* grade. The foregoing figures refer to the grading scale adopted by the Norton Co., as do all other similar references in this article. However, these do not always answer the purpose as well as coarser or harder wheels. Where the contact is broad, or in general surfacing work, 16 grit, *Q* grade will be found to be better adapted than the finer wheels. In a number of instances 16 grit, *R* grade is also used and where a still harder wheel is required 10 grit, *T* and *U* grade are found satisfactory on such work as differential housings, removing gates and fins from journal boxes and other heavy railroad castings, and in a few cases 10 grit, *W* grade, has to be employed. However, the use of such hard wheels is usually made necessary because of the low operating speed, or because of unusual methods of applying the work to the face of the wheel.

In general, we might say that the following three factors influence the size of grain to be used: Size of fins and gates rate of cutting required and character of surface desired. The grade of a grinding wheel on the other hand is dependent upon the following factors: The contact between the wheel and the work, the wheel speed, the size of the castings and the method of applying the work.

Grinding Hard Iron Castings

Hard, or white iron, castings that have not been annealed are usually ground on double-end floor stands. The sizes and shapes of wheels correspond to those mentioned previously. In the case of the unannealed iron, we have a dense, brittle metal, the carbon being combined with the iron. From the standpoint of penetration it is hard, but of low tensile strength. These conditions call for a carbide of silicon abrasive, such as crystolon or carborundum.

The grits employed on these hard castings range from 16 to 24 and the grades from *R* to *U*—crystolon vitrified. The wheel that is found most frequently to meet the conditions imposed by these castings is the 20 grit, *S* grade wheel, although for small castings up to 5 pounds in weight with light fin, 16 grit *R* grade will give satisfaction. Also when a slightly harder wheel is desired, 16 grit, *S* grade will generally answer the purpose

However, the thin, sharp fins that are found on such articles as hard pipe fittings, for instance, call for 16, 20 or 24 grits, *T* and *U* grades. Also semi-automatic means of applying certain hard castings, as agricultural links, to the wheel call for grades *T* and *U*. For the average run of white iron castings, the 20 grit, *S* grade wheel will answer the purpose in 60 per cent of the cases, and the 16 grit, *S* grade in 20 per cent. The remaining 20 per cent will be divided among 16 grit, *R* grade, 16 grit, *T* grade and 20 or 24 grit, *U* grade.

Special Treated or Filled Wheels

Where the work is applied automatically and continuously, there is great danger of excessive heating which sometimes causes wheel breakage. Situations of this nature can sometimes be met by using a special-treated wheel impregnated with a lubricant. This causes freer cutting qualities and thus reduces the heating of the grinding wheel. The treatment usually increases the life of the wheel because much of the dressing is eliminated. These wheels have been perfected so that the lubricant is not thrown out by centrifugal force.

It is advisable to maintain a wheel speed ranging between 5000 and 6000 surface feet per minute. As in the case of steel castings, when the wheels are worn down so as to reduce the surface speed much below 5000 surface feet per minute, they should be transferred to higher speeded grinding machines. The variable-speed motor drive offers another solution of this problem. In any event, allowing the wheel speed to fall far below 5000 surface feet per minute for a very long period results in increased grinding costs and a falling off in production.

It will be found profitable to keep records of abrasive costs and tonnages obtained from each wheel used, where there is continuous grinding. It is only necessary to keep a record of total tonnage ground per wheel and total life of the wheel. From these two figures, and knowing the cost of the wheel, the following values can be computed: Pounds ground per hour indicating the rate of cutting; abrasive cost per ton of castings ground and abrasive consumed in cubic inches per ton of castings ground.

If these values are figured monthly, they give the foundry superintendent or manager an accurate record of what the wheels are doing. It is evident that the abrasive cost per ton of castings ground does not tell the whole story. This value might be unusually low and yet the total grinding costs might be too high. It is possible to use excessively hard wheels and keep the abrasive cost per ton of castings ground low, but the labor cost per unit of output would probably be high.

It is manifestly good practice to keep the factor, abrasive cost per ton of castings ground, as low as is consistent with the factor—pounds ground per hour—and this factor should be based carefully upon what the average grinder can maintain as a fair day's work. In those times when labor is scarce and wages high, it is better to lean toward the softer, free-cutting wheels which are not so difficult to work upon and which permit the workman to turn out castings faster.

The abrasive cost per ton of castings ground will range from 30 to 50 cents in the case of malleable iron castings ground with wheels made of an aluminous abrasive.

Keeping the Records

The keeping of such records makes it an easy task for the foundry operator to intelligently conduct tests at reasonably frequent intervals to make sure that he is using the best wheels for his work. If there is a change in the run of castings it is perhaps desirable to change the grit or grade of the wheels. The following is a simple method of carrying out such a comparative test:

Mount one of the regular wheels on one end of a double-end floor stand and at the same time one of the new wheels to be tested on the other end of the same spindle. Direct the two grinders, take their castings from the same pile and have them change daily from one wheel to the other. Keep accurate records of wheel life and production and carry the tests from one machine to another until all the operators have tried the test wheels. The average result of such a test tells the story as accurately as it can be obtained.

Pointers for the Plater When Buying Equipment

How the Generator Should be Selected and Features to Consider in Selecting the Proper Machines—Tanks, Their Construction Lining and Use

By E P Later

WITH the cessation of hostilities the feverish activity prevalent for so long in many lines of manufacture is quietly subsiding and business men are now turning their attention toward the problems which a return to more normal conditions and a careful consideration of the future are bringing up. Any discussion of what the future holds for us may better be left for wiser heads than mine, but it seems entirely safe and reasonable to predict that there is certain to be plenty of work and business for all. Temporary depressions there may be, but of the ultimate outcome no one need be in doubt. On the other hand, there is also little doubt that competition is going to be keen and unrelenting, not only between domestic manufacturers, but with those of Europe. World markets are open to those who can take and keep them, but to do either is not going to be easy.

Improving Finishing Departments

Insofar as the electroplating industry is concerned, many firms already are planning changes of more or less magnitude in their finishing departments. In some cases enlargements are contemplated and in others a general overhauling of equipment is in order. Therefore, it may be helpful to consider briefly some of the more important apparatus used in the plating room, particularly with reference to the points to be watched in the selection and purchase of them.

As the dynamo or generator is the source of the electrical energy by which all of the plating operations are carried on, it necessarily occupies a very important place in the system and is well worth a little study.

Essentially, a dynamo consists of two or more large electromagnets, heavy iron cores surrounded by coils of wire known technically as the field coils; an armature, which is merely an iron drum or cylinder also provided with coils of wire arranged in a certain fashion; and a commutator, which consists of copper segments insulated from each other and fastened to the shaft of the armature, from which they are also insulated. These segments are connected to the armature coils. Two or more sets of brushes bear on the commutator.

In operation, the field coils are excited or made active by passing a current through them and under the influence of this the iron cores within them become highly magnetized. If now the armature, which is placed only a short distance from the inner ends of these cores, is revolved the lines of force proceeding from the cores are cut at a rate depending on the speed of rotation and an induced current of greater or less magnitude is set up in the armature coils. It is the function of the commutator to collect these alternating currents and send them out from the machine in a continuous stream.

Despite the fact that all direct current generators, say, have substantially the same parts, they are by no means all alike in their characteristics; there are several ways in which the field and armature coils can be wound and connected hence there are several distinct types of machines in ordinary use. Briefly, these are the series type, having one set of field windings and connected up so that the full current of the machine passes through them; the shunt machine, wherein the field coils are also singly wound and connected as a shunt or by-pass across the armature, so that only part of the total current of the machine passes through them; the compound-wound dynamo which, as the name implies, has a double set of field windings, both shunt and series; lastly, the interpole generator, which may be either shunt or compound-wound, with the addition of an entirely independent set of field poles and coils. In point of construction this type of generator is, of course, more complicated than any of the others.

Flow of Electricity Considered

Before going further it may be interesting to discuss some of the facts connected with the flow of electricity through a wire or other conductor. The usual and perhaps best way of arriving at some conception of what it is like is to compare it with the flow of water through a pipe, for there are many points of similarity between the two. Picturing in our minds a reservoir of water placed on a hill, with pipe lines running down to supply consumers, and a pump placed, say, at the bottom of the hill to maintain a constant level of water in the reservoir, we can easily see that the pump is working against a certain *head;* that is, it has to lift a column of water a certain number of feet to the reservoir. This distance determines the pounds pressure of the water in the system and corresponds to the volt-pressure of a dynamo; just as there may be anywhere from a fraction of a pound to many thousands of pounds pressure per square inch in a pipe line, so the pressure or voltage of an electric line may be of almost any magnitude, from the smallest fraction of a volt to hundreds of thousands of volts.

Factors of Electrical Flow

When a faucet is opened in a water line water will flow out, the amount depending on the pressure and the friction or resistance which is encountered. Precisely the same thing takes place in an electrical system. Turning on a lamp, putting work in a plating tank or in any other way affording an opportunity for a current to flow, through the completion of a circuit, results in a passage of current through the various conductors; the amount of current flowing will depend on the pressure, volts, and the resistance of the circuit.

For greater convenience in expressing electrical measurements it has come about that the volt is taken as the unit of pressure; in a similar fashion the ampere is recognized as the unit of current strength or rate of flow and the ohm represents the unit of resistance. The electrical energy derived from a generator or other source of supply and available for doing work is ordinarily expressed as so many watts, which is the product of the volts times the amperes.

The relations between these different quantities are so intimate that they can be expressed in the simple form known as Ohm's law, which is an indispensable tool for anyone who has to deal with electrical appliances. Letting I stand for current or amperes, E for volts and R for resistance,

Ohm's law can be expressed $I = E/R$; therefore, if any two of the three factors are known the other can easily be found, by substituting the respective numerical values in the equation and solving. Thus, if it is desired to know the current flow through a resistance of 400 ohms at a voltage of 110, substituting in the equation we see that $I = 110/400 = 0.27$ ampere.

Looking into this a little more closely we will see that the amount of current which flows through a conductor or solution varies directly with the voltage or pressure; if we double the voltage in a given circuit where the resistance remains constant the amount of current flowing will also be doubled. Remembering now that it is only the current which actually passes through the solution that does any useful work, deposits metal, for the plater, we come to the point of the whole matter: In order to obtain the best results, both in the quality and quantity of the work turned out it is essential that the plater have at his command a source of current at a constant voltage. If the latter is going to vary every time a new tank is switched on or the electro-cleaner put in operation, it is certain that the production of satisfactory work will be much more difficult or even impossible. When one is called upon, then, to select a generator for use in plating the question of voltage regulation comes up prominently.

Voltage Regulation is Important

So long as the load and the power for driving remain constant the voltage of a shunt generator will stay very close to any desired value; the generator field rheostat being used, of course, to bring the voltage to this point in the first place. Any changes in the load are reflected at once, however, in the voltage; it will drop at once with an increase in load and rise with a decrease, which means that every time a tank is switched on or off the voltage across the bars of all of the other tanks then in use will change, thereby making it necessary to use the rheostat to bring the voltage back to the desired point. On the other hand this rather obvious disadvantage is offset to some extent at least by the simplicity of construction which a shunt machine exhibits.

In a compound-wound generator the regulation of the voltage with change of load is much more nearly automatic and is brought about by the addition of a separate set of coils on the field poles, which serve to vary the magnetizing force as the load on the machine increases or decreases.

Interpole generators may be either shunt or compound-wound, usually the latter; so the question of voltage regulation remains the same as in the simple shunt or compound machines, but the addition of the extra poles makes commutation better and thus does away more or less completely with the strong tendency toward sparking at the commutator which many machines, particularly those of poor electrical design, exhibit with changes of load.

Best Type of Generator

Which is the best type of generator for electro-plating? That is a rather difficult question to answer and perhaps this is best shown by the fact that there is a difference of opinion in regard to it. The nature of the work and the standards which must be met may play some part in deciding whether one or the other should be used; in some cases variations in the voltage may be a more serious matter than in others. Then, too, the machines which are simpler in design and construction are, of course, somewhat less expensive than those of more complicated make-up, a factor which may be given undue weight at the time of purchase. It may be recalled, however, that the generator, or anything else for that matter, which is cheapest in first cost does not always maintain that reputation throughout its active life; the time, and consequently money, which a high-priced workman spends regulating and tinkering with a poorly designed generator or one which is not suited for the work may, in a short time, more than offset the difference in cost between that machine and one which would give better service with less attention.

The question of excitation is one which frequently needs to be decided when a generator is being selected. The exciting or field current may be obtained from a small, separate dynamo or from the armature of the large machine itself and circumstances will often dictate which system should be used. As a general proposition separate excitation tends toward steadier operation and when a direct lighting or power current is available it is advisable to use it. With large generators it will often pay to install an exciter, when no other source of direct current is at hand; this is particularly true when a machine is running much of the time below its rated voltage and variation of the speed is not possible. Maintaining the speed constant and obtaining low voltages by greatly weakening the fields is not conducive to steady operation and should be avoided.

When deciding upon the size of generator needed one should be careful to avoid making the mistake of under or over-estimating to any large extent the amount of current required. The maximum should be determined as closely as possible and then any leeway for expansion which business policy dictates can be made. It is a waste of money to buy a machine which is much too large for the duty required; on the other hand, buying a machine which is so small that it will be badly overloaded is hardly a wise thing to do.

The behavior of a generator, as regards heating and sparking, at full and overload is an important feature. The usual requirements are that after a machine has been run at full current and voltage until its temperature becomes constant no part except the commutator shall have a temperature more than 40 degrees Cent. above that of the surrounding air. The permissible temperature of the commutator under the conditions is 45 degrees Cent. A good generator should immediately after this test be able to carry a 25 per cent overload continuously for two hours without the temperature of any part except the commutator rising to more than 55 degrees Cent.; the commutator is allowed to attain a temperature of 60 degrees Cent. above that of the surrounding air. Further, the machine should be capable of delivering for a short time, immediately after the above tests, a 50 per cent overload current at full voltage without serious sparking at the brushes.

Points Relating to Design

There are many other points relating to design, such as the kind of bearings, the size and efficiency of the oiling devices, type of brush holders and so on, which are of some importance, but which cannot be discussed here. After all, perhaps the best way of insuring that all of these things are as they should be is to deal with a manufacturer who is not only known to be reputable, but who has had sufficient experience in the game to enable him to design his apparatus after the best accepted standards of the present time.

As far as the installation and care of generators is concerned everyone knows, of course, that they should be securely mounted on a good, solid foundation, but it may not be so generally recognized that they should be protected as much as possible from the steam and fumes of the plating room. If they are exposed to such corrosive influences corrosion

of the wires and other parts is fairly certain to develop sooner or later and trouble will surely follow. Ordinarily a generator does not require much attention, but the bearings must be kept thoroughly lubricated and a little time spent in wiping off the oil and dirt which will inevitably collect on the coils and other parts will go a long way toward keeping it in good condition.

Protect Electrical Instruments

Ammeters and voltmeters are another important part of the electrical equipment and it is good economy in the long run to purchase only high grade instruments of the rugged design necessary to meet the conditions to which they are exposed in the plating room. It is particularly important that the cases be tight enough to exclude completely the acid fumes and steam which would soon ruin the delicate internal mechanism if they were allowed anything like free access.

In the matter of busbars and conductors generally, nothing is saved by making these too small; for, although something may be realized in first cost, if they are not large enough to carry the necessary current without heating the trouble which is very likely to be experienced through the drop in voltage, together with the electrical losses, will more than make up for any original saving.

The contact surfaces of all joints and connections should be large enough to reduce resistance to the minimum and it is preferable to solder them. Good contacts can no doubt be made by clamping the parts tightly together, but it should be borne in mind that tarnish and corrosion can gradually creep into very small places; therefore, it is better to avoid all possibility of trouble and solder the connections in the first place.

In the same way rheostats should be plenty large enough to perform the service required of them and it is important that the contact points be kept clean and free from heavy tarnish; a rheostat is used for the purpose of cutting resistance into the line, but we want to use the known resistance of the coils and not that which comes from poor or corroded contacts.

Tanks are perhaps next in point of importance on the list of plating room equipment and are worth a little consideration. In this line of industry a variety of liquids ranging from strong acids to strong alkalis must be kept in tanks and so the material from which to construct these is the all-important question. Practical considerations limit our choice of materials to about three: Wood, glass or earthenware and metal, usually iron or lead.

By reason of its cheapness and ease of working wood is extensively employed and as a container for solutions which are not too strongly acid or alkaline, nor used at too high a temperature, it gives fairly satisfactory service, under the proper conditions. There are some points, however, which need to be watched if the best results are to be obtained.

As far as the kind of wood to be used is concerned any one of several, cypress, long-leaf pine, white pine and so on will do well enough, but care should be taken to see that it is as straight-grained as possible, free from knots, because these will likely work out some time and leave a large hole, and well seasoned, thereby avoiding the possibility of shrinking and cracking later on. Whether or not tanks can be made or should be purchased may be open to debate, but for the sake of any who may wish to try it, it may be said that one of the secrets in making a tank which will not leak is in having the edges of the boards absolutely square and straight and then in applying sufficient pressure in the right place, by means of bolts, to keep all of the joints and seams snug and tight.

While tanks will sometimes work very satisfactorily with certain solutions without being lined it is usually safer to coat them on the inside with some protective material such as tar or asphalt. These range all the way from a soft pitch to a hard, brittle substance; therefore care should be taken to select one which is neither so hard and free from elasticity that it may crack in cold weather nor so soft that it will gradually run down the sides of the tank and collect in the bottom in warm weather, or if the solution is heated.

Lining the Tank

A tank which is to be lined should be thoroughly dried out by allowing it to stand in a dry, warm place for several days; then all of the bolts should be tightened up. It is also a good plan to char the inside of the tank slightly with a blow torch since a better surface is thereby obtained for the application of the coating material. The latter should be melted in any suitable container and flowed on hot, laying the tank over on the sides and ends as these are coated in turn. Afterward the coating should be gone over with a hot iron and any rough spots, bubbles or thin places smoothed over and surfaced.

It is also usually advisable to apply a couple of coats of asphaltum paint to the outside of the tank; the first coat should be somewhat thinner so that it will soak into the wood more readily.

Although iron or steel is very readily attached by acids alkalis do not affect it, consequently it constitutes a satisfactory material for the manufacture of tanks for holding cleaning solutions electro-cleaners, hot cyanide baths and the like, some of which destroy wood very quickly. Small tanks are often cast, but the production of a large tank with thin walls is very difficult, consequently they are generally made of sheet steel ¼-inch or so in thickness, riveted or welded together. Either method will produce a tank which is satisfactory insofar as strength is concerned, but it may be observed that unless the riveting and caulking are carefully done, electrolysis is liable to take place between the different sections of metal, leading to eventual weakness and failure; in a welded tank such action cannot, of course, take place.

Silica Sand Producers Form Association

Miners of silica sand in the Ottawa-Utica district, Illinois, have organized the Silica Sand Association of Illinois for the purpose of gathering information relative to the present uses of this sand and to promote new uses by research and investigation. Paul L. Vittur has been elected secretary with headquarters in the Central Life Insurance Co. building, Ottawa. The following are members of this association: American Silica Sand Co., Commonwealth Silica Co., Federal Silica Mines, Illinois Valley Silica Co., Higby Canyon Sand Co., Ottawa Steel Molding Sand Co., Ottawa Washed Sand & Gravel Co., E. J. Reynolds Sand Co., Utica Fire Sand Co. and the Utica White Sand Co.

Branch Managers Appointed

The Standard Conveyor Co., North St. Paul, Minn., manufacturer of gravity conveyor systems, has completed a large addition to its plant which has greatly increased its capacity. Recent changes in the personnel include the appointment of H. C. Christiansen as manager of the Cleveland office, located in the Citizens building, and his predecessor, R. M. Covey, has been placed in charge of the company's Pittsburgh office. The New York office also has been enlarged and W. E. French, sales manager of the company, has been placed in charge of this branch.

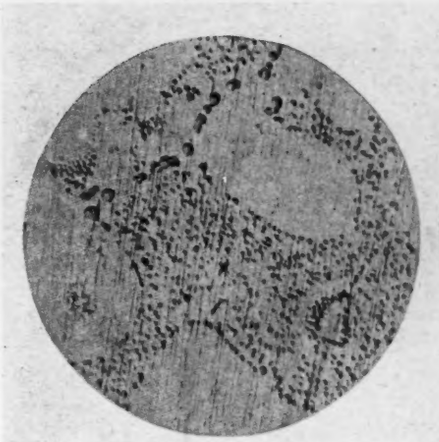


Fig. 1—Electrolytic Copper Ingot, Unetched, Showing Oxidized Eutectic; Magnified 400 Diameters

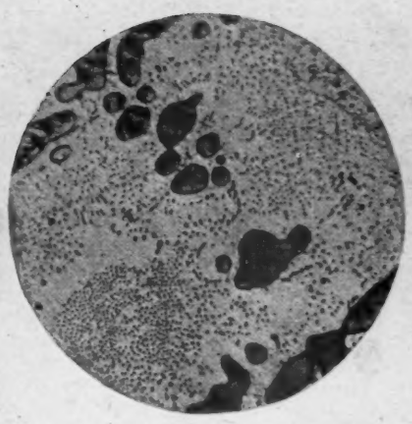


Fig. 2—Badly Oxidized Copper Showing Oxide Crystals and Eutectic; Unetched, Magnified 200 Diameters

Fig. 3—Same Specimen as Fig. 4 After Etching With Ammonia and Hydrogen Peroxide; Magnified 100 Diameters

Nonmetallic Inclusions in Bronze and Brass

By G F Comstock

IN the literature of metallography there is a large amount of material describing the various non-metallic inclusions found in iron and steel, and the appearance of sulphides, silicates, oxides, or alumina in steel under the microscope is fairly well known. The inclusions found in nonferrous metals however, are not so well known, at least judging from published writings, and the author has been interested in examining small castings of copper, brass or bronze with certain inclusions purposely mixed with the metal, to see what was the characteristic appearance of each kind of inclusion, and if they could be readily distinguished from each other.

Presented at the October meeting of the Institute of Metals Division of the American Institute of Mining Engineers. The author is metallographist of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

Copper-oxide Studied

The method employed in most cases consisted in over-heating and oxidizing a small charge of copper, then cooling it somewhat, and adding a suitable amount of the element whose oxide it was desired to observe. This element was stirred in well, and given time to react with the oxygen in the copper, and the melt was finally poured in a sand mold in the form of a cylinder about 2½ inches in each dimension, with a sprue about 1½ inches in diameter and 3 inches high on top of the cylinder, the sprue forming the only riser. Samples for examination were cut sometimes from the center of the casting, and sometimes from the sprue or riser. A few of these samples were cast in chill molds. The appearance of sulphides was studied in an alloy containing 10 per cent each of tin and lead, with which a flux of plaster of paris was used. The appearance of foundry sand was studied in several alloys, one of them having sand stirred into the metal intentionally, and others having cut into the molds badly when poured, so that the castings were spoiled by included sand.

As all this work was done on al-

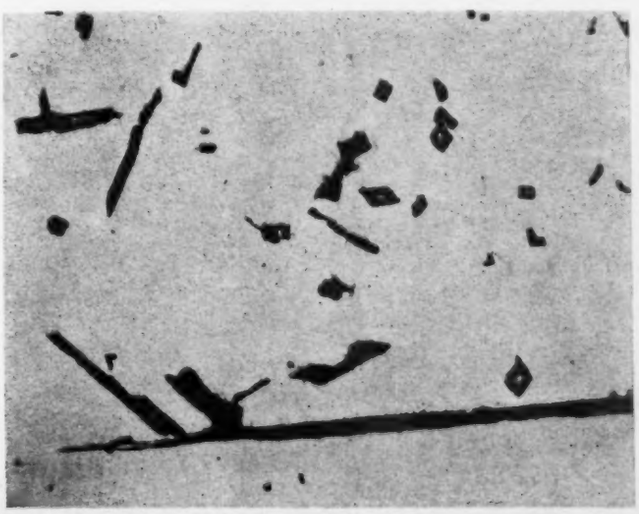


FIG. 4—TIN OXIDE CRYSTALS IN OXIDIZED COPPER TREATED WITH 10 PER CENT TIN; UNETCHED, MAGNIFIED 200 DIAMETERS

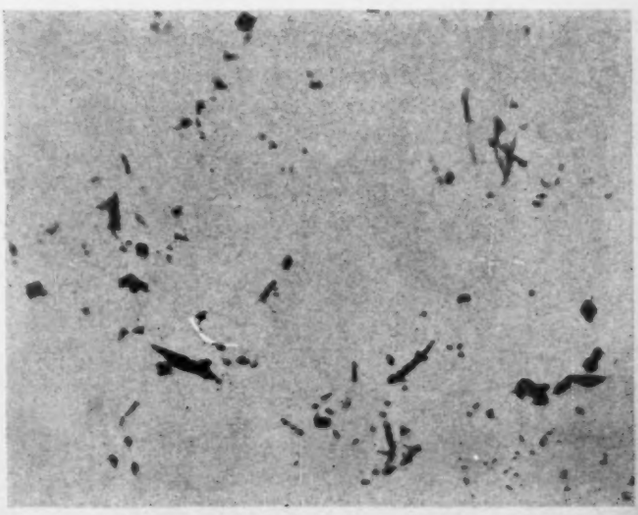


FIG. 5—TIN OXIDE CRYSTALS IN ANOTHER HEAT OF BRONZE MADE AS FIG. 3, BUT CAST INTO CHILL; UNETCHED, MAGNIFIED 400 DIAMETERS

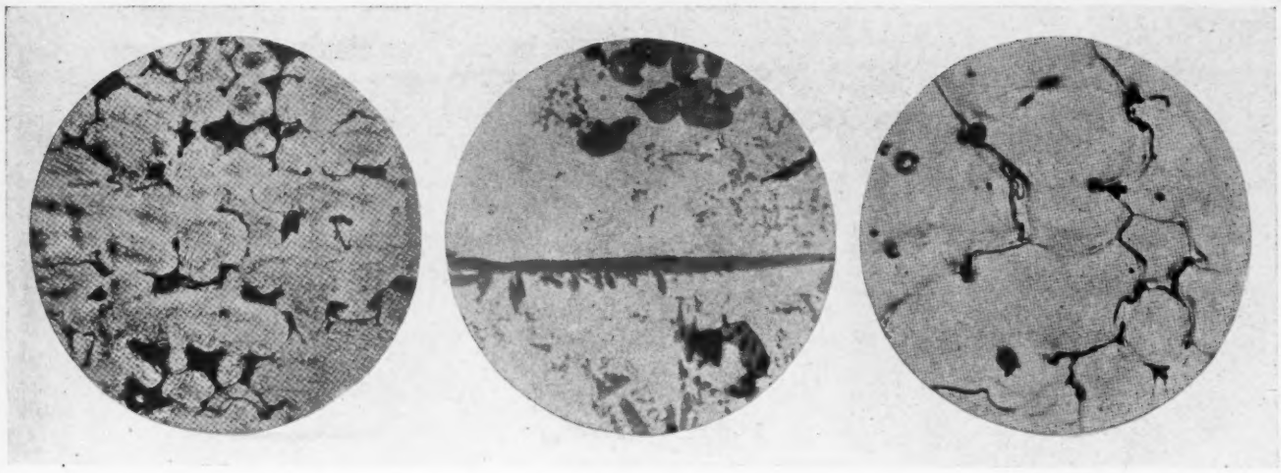


FIG. 6—UNSOUND SPOT IN BRONZE CASTING WITH 12 PER CENT TIN AND 6 PER CENT ZINC; UNETCHED, MAGNIFIED 100 DIAMETERS

FIG. 7—ZINC OXIDE INCLUSIONS IN OXIDIZED COPPER TREATED WITH 30 PER CENT ZINC; UNETCHED, MAGNIFIED 200 DIAMETERS

FIG. 8—OXIDIZED COPPER TREATED WITH 0.5 PER CENT PHOSPHORUS; ETCHED AND RE-POLISHED, MAGNIFIED 100 DIAMETERS

loys whose chief ingredient was copper, the natural starting point was copper oxide, whose appearance in a micro-section is well known. Cuprous oxide is soluble in molten copper, but separates out in freezing, and forms a eutectic containing 3.5 per cent Cu_2O, or 0.39 per cent oxygen. If there is less oxygen than 0.39 per cent, there are primary crystals of copper embedded in the eutectic, and if more than 0.39 per cent oxygen is present, the eutectic surrounds primary crystals of Cu_2O. Fig. 1 illustrates the former condition, and Fig. 2 the latter, both showing unetched samples. The oxide particles are light blue when examined by white light, and contrast strongly with the red background of copper.

Copper absorbs oxygen readily when melted, but when other elements are alloyed with it, the copper oxide is always reduced, and the added element is oxidized. Tin is one of the commonest additions to copper, being used in all true bronze, and its oxide takes the form of angular crystals or needles of a very dark bluish gray color, as shown in Figs. 3, 4 and 5. The first two show views of the same casting poured in sand, but Fig. 5 is a view of a chill-casting, in which the tin oxide crystals are much smaller.

Foreign Substances Excluded

Special care was taken to avoid contamination of either of these heats by anything except copper, tin and oxygen, and in the other cases to be described later equal care was taken to keep the heats free from any undesired element. The poor polishing qualities of these tin-oxide crystals are noteworthy, as they always appear more or less pitted and stand out in relief above the metallic surface with heavy black outlines. This probably indicates that they are hard and brittle. After etching with ammonia and hydrogen peroxide, as in Fig. 3, they appeared still more pitted, as if this reagent had attacked them or partly loosened them from the metallic surface.

It has been suggested that tin oxide occurs as films surrounding the primary crystals of the bronze and although some of these films are seen in Fig. 3, the writer believes that they were caused by gas dissolved in the metal. The reasons for this view are: (1) Because the angular crystalline form is so characteristic of inclusions known to be tin oxide; (2) these inclusions are idiomorphic and are scattered through the bronze crystals rather than between them; (3) the chilled sample (Fig. 5) did not show any of the films, and (4) similar films were found in samples containing no tin, but zinc and phosphorus, whose oxides are volatile. The common oxide films found so

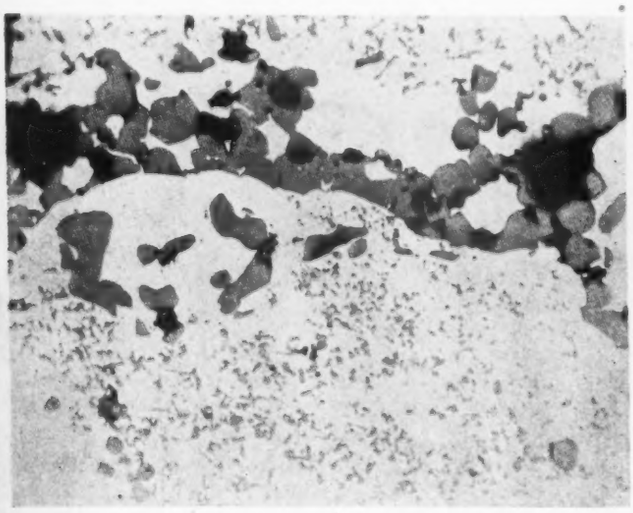


FIG. 9—ANOTHER VIEW OF ZINC OXIDE INCLUSIONS SAME AS FIG. 7

FIG. 10—ZINC OXIDE INCLUSIONS IN ANOTHER HEAT OF BRASS MADE AS IN FIG. 7, BUT CAST IN A CHILL; UNETCHED, MAGNIFIED 400 DIAMETERS

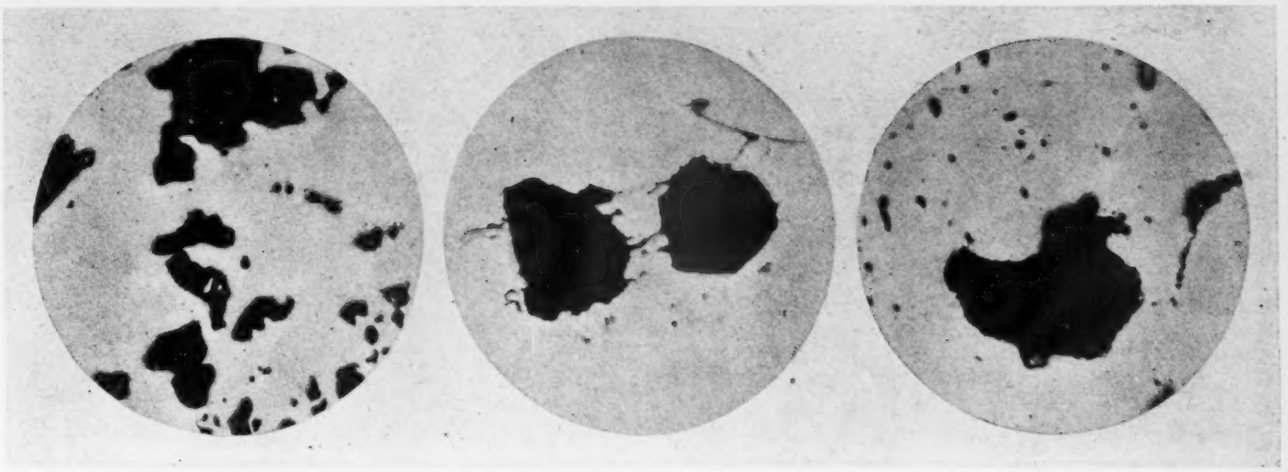


FIG. 11 — BADLY OXIDIZED COPPER TREATED WITH 2 PER CENT PHOSPHORUS; UNETCHED, MAGNIFIED 20 DIAMETERS

FIG. 12—TWO GRAINS OF SAND IN ALUMINUM BRONZE, UNETCHED, MAGNIFIED 200 DIAMETERS

FIG. 13 — A LARGER GRAIN OF SAND IN A BRONZE CASTING WITH 9 PER CENT LEAD; UNETCHED, MAGNIFIED 50 DIAMETERS

frequently in commercial bronzes, therefore, are believed to be caused by either the volatile oxide of zinc or phosphorus or by dissolved gases thrown out of solution when the metal solidifies. These films are illustrated in Figs. 6 and 15. Fig. 6 is an extreme case, where the unsoundness was evident before the specimen was etched. The more usual oxide films, as shown in Fig. 15, do not appear distinctly until after etching, as the polishing seems to make the metal flow over and hide them.

Several unsuccessful attempts were made to examine inclusions of zinc oxide in brass, but at first the only result obtained was an apparently clean though unsound metal with films and cavities like those shown in Figs. 6 and 15. Finally, however, some typical inclusions were obtained in three cases, as shown in Figs. 7, 9 and 10. Some of these appear idiomorphic, but they are distinguished from tin oxide crystals by their lighter color, smoother surface, without very dark outlines, and more rounded form. Fig. 10 shows metal cast in a chill, hence the inclusions are much smaller in it than in the others, which were cast in sand.

Phosphorus Inclusions

Manganese and phosphorus, when added to oxidized copper gave results like those first obtained with zinc, that is, no typical inclusions were found although the castings were not sound. Fig. 8 shows the intercrystalline films produced when 0.5 per cent of phosphorus was used to deoxidize some normal copper. These cavities seem to follow along the lines where the copper oxide eutectic would be expected, had the metal not been deoxidized. Films that have been described as tin oxide are exactly similar to these, which were caused by the volatile oxide of phosphorus. Fig. 11 shows some badly oxidized copper after treatment with 2 per cent of phosphorus. The phosphide eutectic was abundant here, but no non-metallic inclusions were found, the black spots shown being merely cavities.

While on the subject of phosphorus it might be of interest to describe the writer's experience in identifying the phosphide in bronzes, although of course this cannot be considered a non-metallic inclusion. In specimens containing copper-tin eutectoid (or delta) and phosphide, these two hard bluish substances were found to be indistinguishable when etched with ammonia and hydrogen peroxide, or with ferric chloride. But before etching, the phosphide could be distinguished from the eutectoid because it was darker in color and stood out

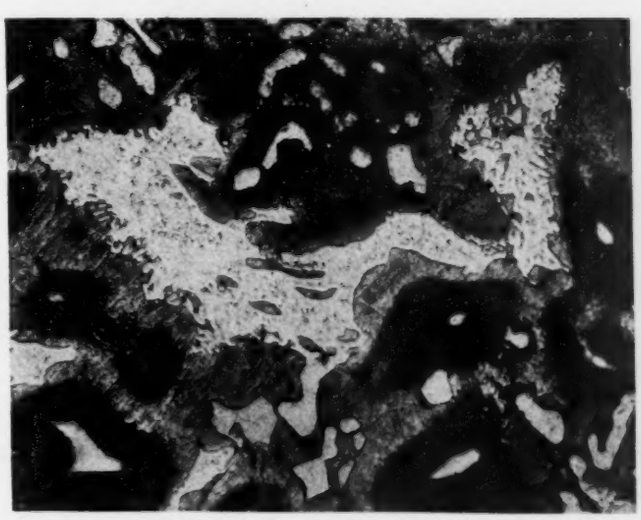


FIG. 14—PHOSPHOR BRONZE SHOWING BLACK SPOTS OF LEAD, (SEE FIG. 21), MAGNIFIED 400 DIAMETERS AFTER ETCHING WITH AMMONIA AND HYDROGEN PEROXIDE, FOLLOWED BY FERRIC CHLORIDE. SOFT CORES OF ALPHA CRYSTALS ARE BLACK LIKE THE LEAD AND THE PHOSPHITE CANNOT BE DISTINGUISHED FROM THE DELTA OF THE EUTECTOID

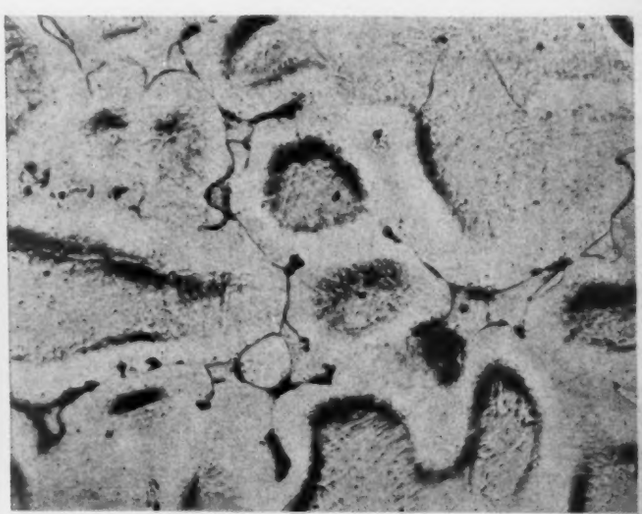


FIG. 15—TYPICAL OXIDE FILMS AND SPOTS IN GUN METAL BRONZE CASTING; ETCHED, MAGNIFIED 400 DIAMETERS

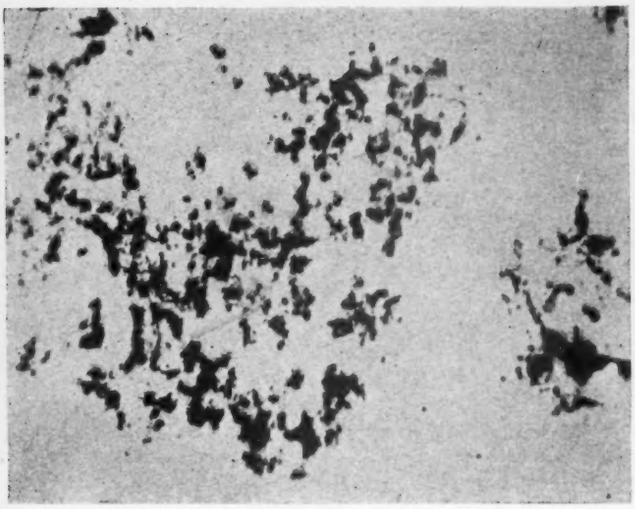


FIG. 16—ALUMINA INCLUSIONS IN OXIDIZED COPPER TREATED WITH 7 PER CENT ALUMINUM; UNETCHED, MAGNIFIED 200 DIAMETERS

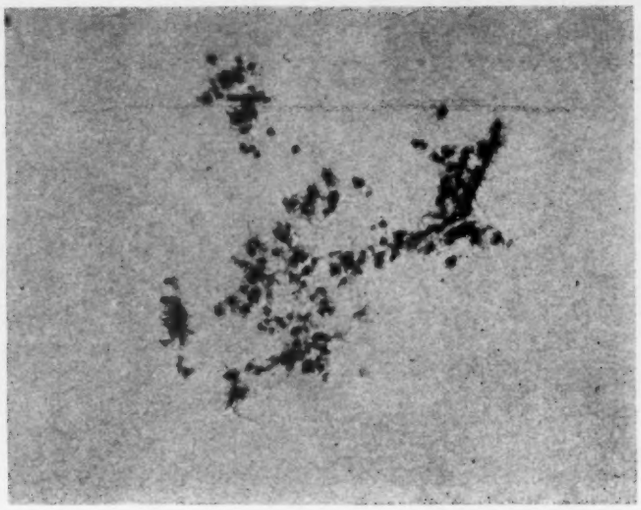


FIG. 17—ALUMINA INCLUSIONS IN A CASTING OF 10.7 PER CENT ALUMINUM BRONZE; UNETCHED, MAGNIFIED 200 DIAMETERS

in relief above the rest of the alloy on account of its greater hardness. Also, after etching with the previously mentioned reagents, if 50 per cent nitric acid was applied, the eutectoid was slightly attacked leaving the phosphide perfectly bright. As little as about 0.1 per cent phosphorus can be detected in bronzes in this way. Figs. 14, 20 and 21 illustrate the appearance of phosphide in the presence of eutectoid when the same specimen is treated in different ways.

These three photomicrographs illustrate the appearance of sulphide as well as phosphide in bronze, as the alloy which they represent was made with a flux of plaster of paris covering it in the crucible. The analysis of the alloy showed 79.3 per cent copper, 9.9 per cent tin, 9.8 per cent lead, 0.4 per cent phosphorus and 0.36 per cent sulphur. In the unetched section the sulphide looked rather dark blue, but when the bronze was made dark brown by the etching reagents, the sulphides appeared very light by comparison, as none of the ordinary reagents attacked them. They had more regular rounded shapes than the phosphides, which had the typical form of a eutectic, as illustrated in Fig. 20. These two substances also can be readily distinguished by the darker color of the sulphide either in an unetched section or after etching with ammonia and hydrogen peroxide. Sulphide inclusions in bronze look very similar to the few samples of zinc-oxide in brass which have come to the writer's attention, but the latter were readily attacked by strong nitric acid, while no reagent has been found which darkens the sulphides in bronze.

The oxide of aluminum, alumina, has exactly the same appearance in bronze as in steel, and Figs. 16 and 17 show typical examples, the former having been made to contain alumina intentionally, and the latter showing these inclusions in a regular aluminum bronze casting. The black specks shown are probably pits in the polished surface, where particles of alumina have fallen out, as these particles themselves are rarely seen in a polished section. The very dark color, small size, close grouping yet lack of coalescence, irregular shape, and rough edges due to pitting, are characteristic of alumina in bronze or cast steel.

It was thought that silica might have the same appearance in bronze as alumina, but the writer has been unable to secure any evidence in support of this view. Several attempts to produce silica in copper by oxidizing the metal and adding silicon were not very successful, and no typical silica inclusions were found. Fig. 18 shows one of the results from these attempts. Part of the view

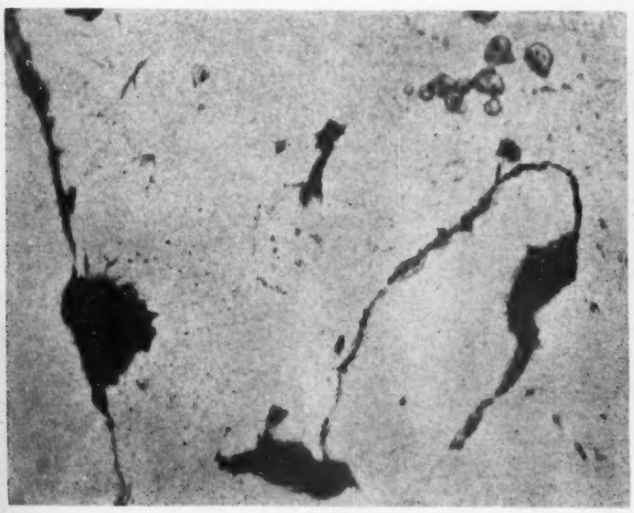


FIG. 18—SILICATE INCLUSIONS AND STREAKS ALONG BOUNDARY BETWEEN COPPER, CONTAINING OXIDE SPOTS AND COPPER DEOXIDIZED BY ABOUT 4 PER CENT SILICON; UNETCHED, MAGNIFIED 200 DIAMETERS

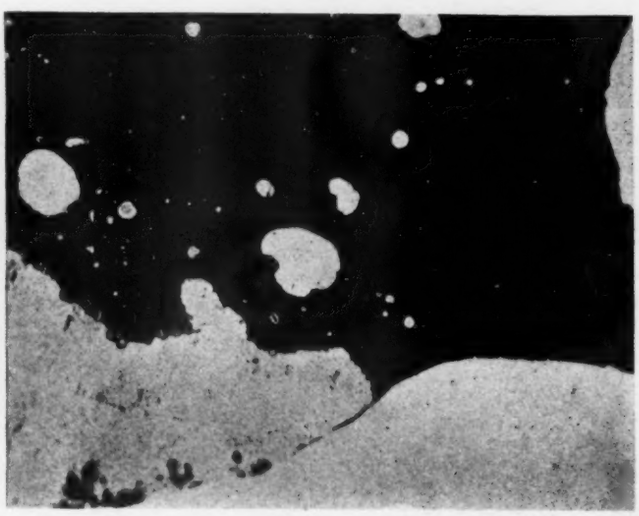


FIG. 19—MASS OF SILICATE SLAG FORMED BY REMELTING OXIDIZED COPPER AND SILICON COPPER TOGETHER, UNETCHED, MAGNIFIED 200 DIAMETERS

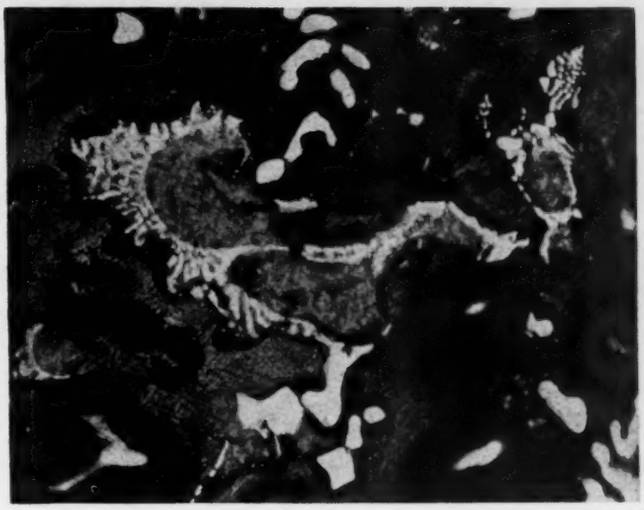


FIG. 20—SAME AS FIG. 14 BUT AFTER FURTHER ETCHING WITH STRONG NITRIC ACID. THE EUTECTOID IS DISTINCTLY DARKER THAN THE PHOSPHIDE AND THE SULPHIDES APPEAR LIGHTER BY CONTRAST WITH THE DARKENED ALPHA

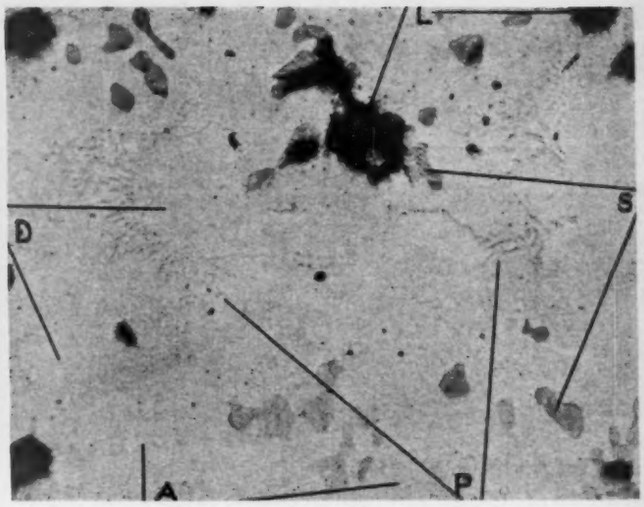


FIG. 21—PHOSPHOR BRONZE SHOWING BLACK SPOTS OF LEAD (*L*); DARK GRAY SULPHIDE (*S*); BRIGHT DELTA (*D*); AND LIGHT GRAY PHOSPHIDE (*P*); IN FINE PARTICLES STANDING OUT IN RELIEF ABOVE DELTA (*D*); AND ALPHA (*A*); UNETCHED, MAGNIFIED 400 DIAMETERS BUT SLIGHTLY REDUCED IN REPRODUCTION

shows oxidized copper, with pale round spots of Cu_2O, and part shows silicon-copper, clean and sound. Between the two are streaks and spots of a very dark material, most of which has apparently fallen out of the section in polishing. This may be silica or a silicate. It has no resemblance to alumina, but resembles slag in steel quite closely.

Fig. 19 shows a mass of silicate or slag included in a chill casting made of oxidized copper and silicon remelted together several times. Some copper oxide is still present in this specimen, but most of the material had been deoxidized by the silicon, and the oxidized product or slag had coalesced into fairly large masses and left the silicon-copper clean. The slag here is not homogeneous, but seems to contain particles of copper oxide or some similar substance.

Figs. 12 and 13 show specimens of foundry sand included in bronze castings, the former being aluminum bronze with sand stirred in intentionally and the latter an ordinary leaded bronze which had burned into the mold excessively and so became mixed with sand at the surface. The angular form of the inclusions in Fig. 12 would indicate that they were grains of sand and not slag formed in the metal, but this distinction is not always so clear. In general, it is probably reasonably safe to say that where smooth dark gray inclusions like these are angular in shape or have convex sides, they are sand grains; and when their sides are concave, they are slag inclusions. The writer is not aware of any other distinction between slag inclusions and grains of sand either in bronze or cast steel. It should be noted in this connection that it is more difficult to polish a sample of bronze containing sand than a similar sample of steel, without having the sand fall out leaving merely pit or cavity in the finished section. The cavities thus left cannot generally be distinguished from cavities caused by shrinkage, gas, or a volatile or powdery oxide of some element like phosphorus or zinc.

Particles of alumina in bronze or steel, however, are so fine and so intimately mixed with metal, as shown by the microscope, that in machining, while the point of the tool may be dulled by them, it is very doubtful if they ever break out of the metal chips in sufficient quantity to be recognized as a white powder.

In presenting these notes the writer does not claim to have made any remarkable discovery or to have found the best method for identifying the non-metallic inclusions in nonferrous metals, nor does he claim to be able to identify every inclusion that may occur in a bronze. It is hoped these notes will accelerate investigation.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

A Mixture Suitable for Small Motor Castings

We are making brass castings for the motors of washing machines and would like to know what is the best alloy for the purpose, whether red or yellow brass? We want a metal that can be machined well and is not subject to corrosion to any great extent. We also have other castings, small in size and of red brass, which have small shrink holes at the gate. We would like to use these castings and wish to solder the defects.

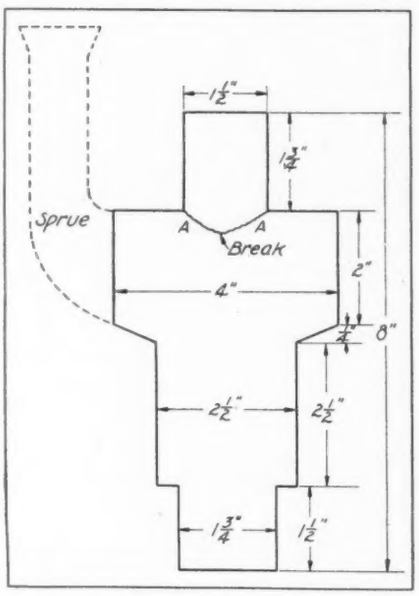
An alloy suitable for brass castings for small motors follows: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent and lead, 5 per cent. This alloy is easily machined and will withstand corrosion as well as most copper alloys. In making castings to withstand corrosive influences it is important to conduct the melting and alloying operations in a manner calculated to reduce the oxidation of the metal to a minimum. The alloy should be covered with charcoal and additions of salt or carbonate of soda should be made. It is more important to get castings free from oxides than to use expensive, so-called anti-corrosive alloys later on.

With regard to soldering the same red brass castings, it is not possible to do this as no alloy is known that will melt at a low temperature and have the color of red brass. The shrinkage at the gate can be prevented by the use of larger gates, or by arranging the runners so that they will feed metal to the casting as it shrinks.

Boss Draws Away From the Hub

We have experienced considerable trouble in making brass bushings of the size and shape shown in the accompanying sketch. These castings are molded vertically and are gated as shown. The castings persist in cracking and breaking as indicated by the line A. This hub does not always break off entirely, but may easily be broken when the casting is cold. Can you tell us what causes this? We would also be pleased to have you outline a better way of molding this casting. The alloy consists of 10 pounds of copper wire to 90 pounds of scrap brass, such as valves, harness trimmings, etc. The melting is done in a coke-fired furnace, using an open crucible, with no flux or charcoal on the metal. When poured, the metal gives off sulphurous fumes, and after the crucible is skimmed just previous to pouring, the surface of the metal becomes covered with mossy looking spots, that appear to burn with a sulphur blaze. The castings are to be machined all over and must be clean.

To prevent the boss cracking as shown and if it is considered desirable to continue to mold them upright, the boss or hub should be tapered with the heaviest section at its junction with the body of the casting. The taper will prevent the sand from holding the boss so that the body can shrink away forming the crack. The riser should be 3 inches in diameter and the metal should be poured into a 1-inch sprue connected by a gate, ¾ inch in area, which connects at the bottom of the casting. The best way to mold this casting is horizontally in a two-part mold, using a rather coarse sand, and the impression of the pattern should be given a coating of silver lead, applied with a camel's hair brush and polished with the fingers. Run a horizontal gate in the drag alongside the pattern at a safe distance therefrom. At one end of the gate put the sprue, 1 inch in diameter and locate the sprue at the end farthest from the heavy section. The other end of the runner should be connected to the end of the boss in a curve. A riser, 3 inches in diameter and at least 4 inches higher than the top of the casting, should be placed so that it can be connected to the heavy section just where the gate is attached in the sketch. The gate should be cut one-half in the drag and one-half in the cope, and should be oval in section, 1 inch wide and 1½ inches high. Pour the casting with metal that looks bright, but is not obviously *hot*. Experience has to determine this point. In pouring, slacken as the metal comes up the riser, dribbling it as the heads become filled. If the heavy part should shrink, when this procedure is followed, build-up the riser 3 inches above the top of mold and when the sprue has been filled, cover it with sand; bed a weight thereon, then fill the riser



SKETCH OF A BRASS CASTING SHOWING WHERE THE BOSS DRAWS AWAY FROM THE HUB

gently. Have the extension on the riser larger in diameter than the body of the riser.

In melting the metal, leave out the 10 pounds of copper wire and use hardwood blocks, enough to burn to charcoal that will cover the metal thoroughly. Place the blocks in the crucible with the cold charge of metal, putting them on top. Use a deepener on the crucible consisting of an old pot with the bottom cut off. The deepener forms a hopper, permitting enough scrap to be charged cold to fill the crucible when it is melted. Keep the metal covered at all times, and just before removing the pot, about 10 minutes or so, add one-third of a can of common lye wrapped in paper; allow it to remain on the metal a few minutes to drive out all water then stir it in. Soda ash can also be used for this purpose. The sulphurous smoke is a gas known as sulphur dioxide, which is produced by the union of oxygen and sulphur in the metal. The oxygen comes from the air, as the metal is exposed, and the sulphur comes from the coke.

Overcoming Porosity in Bronze Bushings

Recently we have experienced considerable trouble from porosity in making bronze bushings, although we have made these castings for years without trouble. We use an alloy consisting of 400 pounds of red brass scrap and 200 pounds of trolley wire alloyed with tin, zinc and lead to form an alloy of approximately 85 copper, 5 tin, 5 zinc and 5 lead. We also add 1 pound of phosphor tin to the mixture to clean it of oxides. The mold is gated at the bottom and an auxiliary gate is placed half way up the casting which is molded vertically; a big riser, holding from 75 to 100 pounds is placed on the casting at a point opposite the sprue. The mold is well vented and is coated with plumbago mixed with molasses water, which is painted on and then well dried.

Sponginess and porosity in brass castings are caused by the metal absorbing and retaining gases, that is, it becomes aerated just the same as water and other fluids, and the degree of aeration determines whether the castings will be porous or spongy, as the more air there is contained, the larger will be the holes, because the tendency of the air is to collect together and form large bubbles. No doubt some gases have a greater tendency than others to collect into large bubbles, and thus produce spongy rather than porous castings.

The cause of the trouble is usually due to the melting practice. The fuel may contain more sulphur than formerly or a new melter is less careful than the former employe in charge of this work. See that the metal is covered with charcoal and use a flux consisting of a can of common lye mixed with about half its bulk of chalk and three times its bulk of powdered charcoal. Place about a pound of this flux in the bottom of the crucible before the metal is placed therein and to prevent the flux from eating away the crucible bottom, place the flux in a piece of the bottom of a small crucible. Set this in the large crucible and cement it in place with a mixture of water glass and plumbago. Do not mix the plumbago with the molasses formerly used as this may contain sulphur dioxide. Use a little glue water instead, or glucose, or a weak solution of water glass. Carefully compare present practice with the methods used in the past, as the difficulty is due to some slight changes that were made thoughtlessly.

Standardized Accounting Systems Recommended

One of the Great Lessons of the War Period is the Need for Accurate Cost-Finding by Practically All American Industries

By William B Colver

DURING the 19 months—April, 1917, to November, 1918—during which the United States was a belligerent in the world war, American industry and finance passed through an ordeal that brought both strength and weakness into sharp relief. Before this nation could strike its full stride things were reduced to rather elemental and primitive terms. Much of mystery and of pretense was swept away.

During these 19 months the federal trade commission had a peculiar opportunity to sense what was going on, especially in the industrial world. It has been the cost finding agency of the government; the expert accountant to the war industries board and its price-fixing committee, to the army, the navy, the food administration, the fuel administration, the railroad administration, the shipping board, the postoffice and other agencies.

It is to be remembered that cost-finding and price-fixing were two entirely different functions. One was a striving for exact fact through painstaking study and labor; the other, building on this fact foundation, was a matter of discretion, of judgment, of accommodation to seen and unseen forces and an effort to distribute equitably the hardships inevitably resulting from the dislocations of war.

Searched Into Vitals of Industry

In its cost-finding work the federal trade commission of necessity had to search into the very vitals of industry. Some took this as a matter of course, appreciating at once the end in view. For some other industries, however, such intrusion into the privacy of business was met at first with reluctance and misgivings. For the latter this attitude quickly changed, and these industries also welcomed and aided the commission in its work. At the end it can be said that there remains no suspicion that a single business secret has been betrayed. Costs were secured from whole industries, sometimes involving in a single inquiry the examination of the books of thousands of companies. These results were brought together and presented without disclosing the identity of individual figures except to the responsible officers of the government, and after opportunity for scrutiny by each concern of the processes and results as to its individual case.

Thus came confidence and understanding where impersonal discharge of duty was met with candor. The vast majority of patriotic and enlightened men of affairs welcomed every effort to steady and stabilize industry as it gathered its vast powers to ride the red seas of war and to deliver the tremendous blow against the enemy.

To Help Industry

Standardized accounting systems, suited to the various industries.

Cost and profit accounting for individual products.

Reasonable standardization of products and elimination of excessive costs due to unnecessary multiplication of styles and types.

Compilation and issue of current, basic trade information.

Conferences between industries and government for the exchange of proper and useful views and information.

Before this country entered the war, and, therefore, before war powers could be exercised in control, a huge and false price structure was built up, and in spite of all that could be done, became more aggravated. Cost of living and wages went upward as prices rocketed. That price structure and its attendant inflations today, are among the chief perils of the reconstruction period. That they are no greater can be attributed almost wholly to the co-operation of industry in the program of price-fixing which checked, so far as possible, mounting prices and, for the time, negatived price based solely on supply and demand.

One great handicap lay in the fact that basic natural resources had been appreciated in value before the price-fixing function came into operation. European belligerents had for three years been bidding, frantically, for the treasures that nature had placed under our stewardship, and as a result our raw materials had been hugely written up before the United States entered the war. So when price fixing was undertaken it started from inflated value for undug ores and coal; untouched petroleum and uncut forests. Despite this false start and the difficulties that flowed therefrom, cumulating in all subsequent industrial operations, price fixing did stabilize industry and insured it against ruinous collapse at the end of the war.

It is estimated that in its work for various government agencies, the federal trade commission obtained cost and production figures of upwards of 10,000 companies in scores of important industries and many minor ones, which had an approximate aggregate investment of 20 billion dollars, and the commodities directly affected by such cost-findings represented annual sale values of at least 30 billions of dollars, not far from twice the amount of the first, second and third Liberty loans taken together.

Accounting Deficiencies

These cost studies by the commission demonstrated frequent and great deficiencies in the accounting methods employed by mining and manufacturing concerns and especially in cost accounting methods.

In some of the oldest and greatest industries there was not even an attempt at that determination of unit costs and profits by products which is essential, generally, to the safe conduct of industry.

It is evident that where such cost accounting is not established it should be introduced and where it is defective, it should be reformed. Inventories should be carefully kept; labor and material used should be accounted for as used; indirect and overhead charges should be fairly allocated and proper allowance made for depletion and depreciation of resources and plants.

On the other hand, capital charges for construction should not be mingled with operating or production expense, nor should there be introduced items of actual or imputed outgo such as income and profit taxes, depletion or

Address delivered by by the chairman of the Federal Trade Commission, before the American Academy of Social and Political Science, Philadelphia.

appreciation of plant investments, or interest on capital owned.

However, where complete records are kept, it is relatively easy to correct bad principles, reject improper items or introduce omitted ones.

Inventories and records of expense and sales by products are necessary to compute profit and loss by products.

Defective Cost Methods Prevail

The business world, well aware of the extent to which defective cost accounting methods prevail, is alert to promote reforms. A few years ago the federal trade commission initiated an effort to be helpful in this direction and applied to congress for funds to carry it on. As these were not given the movement lagged, but as a result of the commission's enforced studies and as a by-product of its war work, that effort may well be profitably and economically resumed. If the earlier effort of the commission could have gone forward before the war, the government would have been repaid many times over during the war through making it possible to ascertain costs much more expeditiously and cheaply.

In the immediate future the question of costs will be especially critical for the nation's business in arriving safely at postwar readjustments. The matter is important to the individual producer, to his banker and to the industry and the public at large.

The cost and profit findings of the commission developed many facts of interest, but was done under such pressure that there has been little time as yet to analyze or interpret the results. Two facts, however, which are generally known, may be mentioned.

First, the average cost during the war period was much higher than before the war. Such increases were frequently as much as 100 per cent.

Second, the variation in costs between different companies, often considerable in normal time, was enormously exaggerated under war conditions.

The great increase in average cost was due in part to increase in cost of the instruments of production and material and supplies; to increased cost of labor partly through increase in wages, but more through violent and frequent shifting of labor and a consequent loss of the efficiency that springs from organization, habit of work and special skill; to wastes caused by effort for increased production and, of course, to the general depreciation of money in terms of goods or services. The cost of living continued to mount rapidly and with it, wages and labor cost.

Fundamental to the cost increases, however, was the writing up of values of natural resources. This tended to bring about the production of raw materials from relatively barren or inaccessible sources with a consequent diversion of labor, capital and transportation to uneconomic operations. It is doubtful whether high prices did really stimulate production to the degree generally believed.

Where there were successive stages of production in an industry (sometimes integrated and sometimes independently operated) the costs were increased by the taking of high profits between the successive stages of production. High costs or high profits, or both, in one stage had a cumulative effect on costs in all succeeding stages—a sort of pyramiding of cost. Price fixing, arriving too late to get at the source of the trouble in the short space of the war, was useful in checking its unlimited extension.

The abnormal variation in costs came largely from the bringing in of uneconomic supplies of raw materials and the writing up in value of advantages by integrated concerns and those controlling natural resources. Congested transportation and dislocation of labor with the consequent irregularity of industrial operations also made for wide cost variations.

Sources of Costs

In considering such variations, however, it should be borne in mind that the lower cost company may not be more profitable than the higher cost producer even when both sell at the same price. Often the lower cost is the result not of greater economies or natural advantages, but of investment in more stages of production or in more extensive mechanical equipment and the larger unit profit resulting from the lower cost is absorbed in providing the proper return on the greater unit investment.

Not the least benefit of cost-finding, incident to price fixing, was the bringing together, with government officers, of the representatives of the industries for full and frank discussion of costs, methods and products.

This, with the assembling of such a body of current data as was never before had in this country, demonstrated the value of such meetings and of the preparation and exchange of such proper and useful information.

It would seem that the commission might well continue, at least as to certain industries, this assembling and distribution, currently, of basic and reliable information and that, well within the law, industry, meeting with government officers might continue to exchange helpful experiences and information without the danger of being suspected of price fixing or other restraints of trade.

If certain laws, enacted to deal severely with admitted abuses, are fully observed in their spirit, in this manner, it would seem that the public interest would be fully served. In such case, a peace-time adaptation of the war-time meetings between individuals and government for frank discussion, would be as helpful as it would be innocent of wrong intent or harmful effect. Such open conferences might be expected to serve all the good and necessary ends which are among those sometimes sought by clandestine meetings. Pursued in the generous American business spirit of fair play such conferences might be extremely useful by ascertaining the facts and clearing away doubts and suspicions.

Standardized Costing Recommended

From the experience of cost-finding, we believe we may argue for:

Standardized accounting systems, suited to the various industries.

Cost and profit accounting for individual products.

Reasonable standardization of products and elimination of excessive costs due to unnecessary multiplication of styles and types.

Compilation and issue of current, basic trade information.

Conferences between industries and government for the exchange of proper and useful views and information.

As a nation we organized lines of supply and communication from Chile and Australia and Alaska and from every state and every farm and factory, and through these lines across oceans and continents to the battle front of France. As a nation we arrived at a power to dispatch a ship loaded with men and food and supplies, on the average, of every ten minutes night and day, Sundays and holidays.

As a nation we launched ships at the rate of 490,000 gross tons a month —or about 700 tons every hour, on the average. As a nation we armed and sent across the sea, our young men, true crusaders of democracy, at the rate of 10,000 a day. As a nation we threw upon liberty's altar billions and billions of dollars in loans—about $500 at every tick of the clock, day and night, Sundays and holidays.

Such a nation, as a nation, may turn with confidence to the solution of whatever problems of industry or finance that the future holds in store.

Quantity Production of Small Iron Castings

Sources of Loss in the Coreroom, on the Molding Floor and in the Cupola Are Traced and Analyzed

By Clement A Hardy

CONCURRENT with the development of the molding machine and the increasing demand for large quantities of duplicate castings, various systems have been tried in foundries to increase production. These systems have been installed to enable the use of molding machines at their capacity and for the purpose of deriving the benefit of the consequent saving in labor cost. Moving tables and revolving platforms for carrying molds, pouring and shaking-out, installed in conjunction with elaborate conveying and mixing apparatus have been tested. Pouring, shake-out and sand-cutting gangs, continuous pouring and other methods all have been tried.

Causes of Foundry Losses

While the molding machine is functioning satisfactorily, yet foundry losses are too great for good practice. This cannot be attributed to the molding machine, but must be assigned to one of the following causes:

Bad iron, due to the operation of the cupola at a low melting rate for long periods, owing to the inability of taking care of the iron at a faster rate.

Bad cores, due to the lack of proper handling equipment, particularly for light cores and the consequent slight breakage of cores which shows up only in the finished castings.

The improper distribution of iron is another cause of foundry loss. Iron for small castings should be poured as quickly as possible, yet it is frequently delayed in handling from the cupola to the mold and bad castings invariably result from the last molds poured from the ladle. The same is true if the iron is distributed in a ladle which is too large. If a ladle is employed which is of too great a capacity for the work, the constant tilting to fill the small ladles rapidly cools the iron. For this reason the sizes of both hand and distributing ladles must be carefully considered to obtain the best results.

The improper gating of molds and pouring are additional sources of loss. The gates for all castings having thin sections, should be ample to permit of quickly pouring the molds. Poor pouring practice increases the foundry losses materially.

Where pouring is done continuously and the sand is used over and over again, losses increase abnormally. No method for artificially cooling the sand, cutting and tempering it, has yet been devised which works as satisfactorily as permitting the sand to cool naturally. Therefore, to reduce losses from bad castings to the minimum, the sand should be used only once daily. The preparation and cutting of the sand after cooling can be performed by several mechanical processes, but to maintain an average of small losses on light, thin work, particularly cylinders, the sand should be allowed to cool naturally and should be screened, cut and tempered by a night gang.

Poor cupola practice is another source of foundry losses. If the cupolas are not properly lined-up and chipped-out each day, so that the iron tapped out is of uniformly high temperature, the losses will increase from the iron poured in the latter part of the heat. Too much care in this connection cannot be exercised.

For the purpose of operating cupolas continuously, their inside dimensions frequently are reduced by increasing the thickness of the lining. A small cupola does not operate satisfactorily on long heats and frequently only dull iron can be obtained during the last two hours of operation of such small furnaces, with a consequent heavy loss from bad castings.

System Recommended

However, losses may be reduced to a minimum and the molding machines may be operated at capacity throughout the day by the adoption of the following method:

The molders mold throughout the day. Throughout the morning the molds are laid out on the floor in the usual manner. The coremakers also make cores throughout the day. The core room, with sufficient oven capacity to take all cores as fast as made, should also be provided with suitable equipment for handling cores and to prevent shaking down small cores. A shake-out gang follows the pouring gang and continues its work until all of the castings are shaken-out. The night gang removes all castings to the cleaning room, sorts them for cleaning and collects sprues and bad castings. The night gang also screens, cuts and tempers the sand and distributes it on the floors, ready for the molders to begin work in the morning. This completes the cycle of operations.

The method of distributing the iron should be by I-beam trolley with small hand-power cranes over the molding floors to handle flasks where these are too large to be closed by hand. This involves light, low buildings, not excessive in cost. Where part of the product is too heavy to be handled except with electric cranes, then one or two sections of the buildings can be raised to accommodate this work.

One great advantage of this method of operation is that a larger cupola can be employed and it is operated a much shorter time than if driven continuously and the liability of bridging or cutting-out is greatly reduced. Also, the last iron is delivered as hot as the first and the foundry is free from smoke for at least half of the day.

Mechanical Charging Saves Labor

Mechanical charging will effect a great saving of labor. No night gang is required to make cupola repairs and the mixture also can be more carefully controlled than when operating continuously. Other advantages are obvious. The molds rest on the floor until poured and are not subject to shake-downs due to handling by conveyors or cranes. Also, the molder is far enough from the hot metal during pouring so that he is not interfered with the greater part of the day. Throughout the morning the aisles are clear for the distribution of cores, new sand, facings, etc., and for the pouring gang in the afternoon.

By this method of operation, the amount of moving mechanical equipment that must be installed is reduced to the minimum and the chances for tying up the entire foundry except for an accident to the blowers or cupolas, is eliminated. The final result is that the foundry losses are reduced considerably below those possible where continuous pouring is

practiced and are very much lower than in shops employing conveyor turntable systems.

It is true that a greater floor space is required to operate a shop as outlined, but the cost of this increased floor area is more than compensated for by the reduced cost of the equipment installed, and the consequent reduction of foundry losses continues as a permanent gain. The details and general dimensions of the building, of necessity, must be adapted to each variety of work and the molding floors should be laid out accurately to accommodate the output required. However, all of this information should be available before the building plan is made and the structure should be built around the floor space required by the layout. Otherwise, it will be difficult to obtain the last per cent of saving in production and it will not be possible to secure the best results in a foundry laid out in an oblong square and covering a prescribed number of square feet of floor space, when no attention has been given to the location, shape and size of molding floors required by each of the various classes of castings to be produced therein. It is most essential to classify the patterns carefully and to group those requiring similar sand and similar iron. This is the province of the foundry engineer, but he must work with the trained foundryman to produce results. If the proper investigations are made, they will be in agreement regarding methods to be pursued and the necessary machines to be installed. In no branch of engineering must practical experience be followed more closely than in that of foundry design, construction and equipment. Dreams and experiments are too expensive in cash and trouble.

Method of Casting Thin-Section Hollow Articles

IN casting hollow articles with comparatively thin sections, it is well known that quite a loss is entailed through the castings cracking as the metal cools. To provide means for casting hollow articles with a low percentage of loss, two inventors, W. L. Mersfelder and A. F. Radka, both of Detroit, recently obtained a patent on a mold for hollow castings and the method of forming them.

The method relates particularly to molding such articles as hollow cast

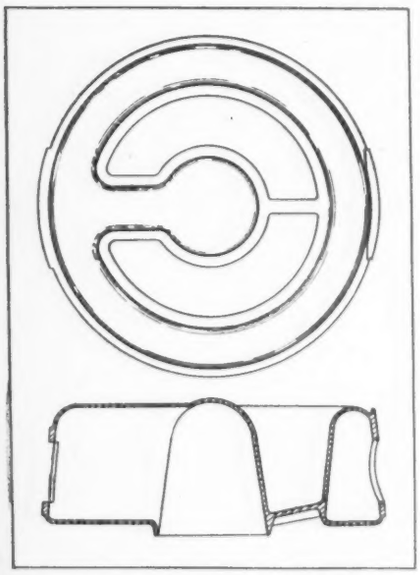


FIG. 1—HOLLOW FURNACE RING

rings used in heating furnaces, as shown in Fig. 1, and the process followed is novel and interesting. It is pointed out that castings of this kind are generally molded with a baked core. Owing to the large diameter when compared with their comparatively thin section, such castings are difficult to make as the uneven contraction of the metal, while cooling, causes fractures.

In this method, the loss is said to be almost entirely eliminated by the em-

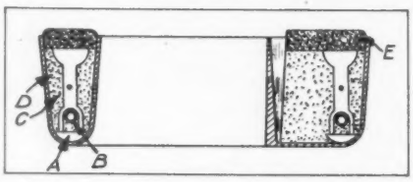


FIG. 2—METHOD OF FORMING THE CORE BOX

ployment of a green-sand core in place of the baked core generally used. This core is thoroughly vented to permit the escape of steam and gases.

As a core made of green sand is not sufficiently strong in itself to be supported in a mold according to usual foundry practice as followed with baked cores, the green-sand core is supported on a base of baked sand. Means are also provided for reinforcing the green-sand core to prevent the upward stress caused by the flotation of the molten metal.

Coreing the Castings

The cores for these castings are formed in a metal core box as shown in Fig. 2, the cross-section of which corresponds to that of the casting to be molded. In the bottom of the core box several small metal plates or chills are placed. These are shown at *A* and are distributed evenly. Over these supports a perforated circular vent pipe, *B*, is placed. This is connected with a pipe running out of the mold. Metallic posts, *C*, are next placed on the metal supports. As the illustration shows, the lower ends of these are forked to straddle the vent pipe. The green-sand core is represented at *D*, and *E* is the baked base. After the core is formed, the core box is turned over and the core removed.

The several steps taken in forming the outer mold are shown in Fig. 3. The drag section, *A*, is formed by the pattern *B*. The core, *C*, for the dome of the casting is also formed in the drag. The drag section is struck-off at the line *D* after which the cheek section, *E*, is placed in position and rammed up. Connected with the plate *G* are lifter rods *F*. These are placed in the segmental spaces between the dome and the outer ring. Sand is filled into these spaces, and after striking off the cheek section on the line *H*, the cope section, *J*, is placed in position. Sand is filled in which unites with the sand in the segmental spaces.

The cope section is provided with the usual cross bars, *K*, for holding the sand in suspension. The sections are separated, the pattern drawn and the core placed on the drag, in which position it is supported by chaplets at *L*

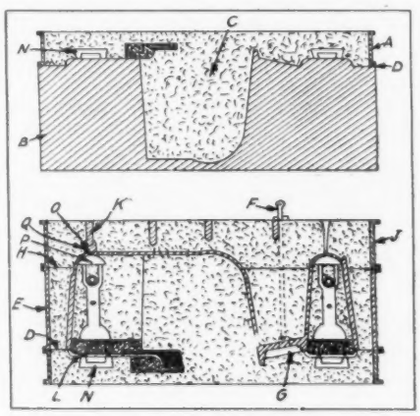


FIG. 3—DETAILS OF MOLDING

which rests on the lugs, *N*. Chaplets, *O*, are also placed in contact with the metal supports, *P*, at the top of the core in position to bear against the lugs, *Q*, when the cope is in place.

Thus, after the cheek section and cope section are placed on the drag, the core will be securely supported against flotation.

In casting, the contraction of the metal is unobstructed as the green-sand core yields as pressure is brought against it. Steam and gases are carried away by the vent pipe, Fig. 3.

Plan National Adoption of the Foundrymen's Safety Code

The safety code of the American Foundrymen's association will be approved, in all probability, by the bureau of standards and will be recommended for adoption by all foundries in the United States not members of the association and for universal acceptance by state safety commissions as the national foundry standard. This possibility is foreseen in a statement by the bureau, through its safety expert, Dr. M. G. Lloyd, following a conference in Washington, D. C., on Jan. 15. At this meeting consideration was given to the purpose of the bureau to formulate national industrial safety codes.

Announcement by the bureau said the nationalization of safety standards "will be done in co-operation with all organizations having an interest in the subject." This was further amplified by Dr. Lloyd who said the intention is to utilize, as far as possible, such codes as are already followed generally by the industries affected. Upon the general use of the association's uniform code will depend its adoption by the bureau of standards as one of the series it hopes to formulate.

Dr. Lloyd pointed out that many of the state commissions, lacking expert opinion, decline to accept trade standards because they do not conform to the respective commission's ideas or are looked upon as codes which have been drawn up for the special interests which have fostered them rather than representing standards of equal interest to the welfare of all concerned. The bureau seeks to interest all the organizations affected by certain codes to study the question jointly and to agree upon the final product.

At the conference on Jan. 15 these points were presented for the benefit of approximately 100 representatives of state commissions, engineering and utility associations, insurance organizations, employers and employes, manufacturers, safety engineers and several government bureaus. No separate standard as such was considered. The sentiment expressed at the meeting was that the bureau of standards should mail to each organization a statement of the projected work and the plan which was presented for handling it. The American Engineering Standards committee which is now being organized by the national engineering societies was mentioned as a suitable channel for co-ordinating engineering work by different organizations. The views of industrial organizations to be collected by mail will be presented at subsequent conferences similar to the one at which this course was decided.

Later, it is anticipated, committees will be named to take up the various phases of the work, possibly a committee for each separate industrial standard safety code. This was the bureau's procedure in adopting a national electric safety code.

Among those prominently interested in the conference were: H. J. Boggis, Taylor & Boggis Foundry Co., Cleveland; F. E. Morris, American Rolling Mill Co., Middletown, O.; John A. Oartel, Carnegie Steel Co., Pittsburgh; James M. Woltz, Youngstown Sheet & Tube Co., Youngstown, O.; C. B. Auel and R. W. E. Moore, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; I. F. Baker and L. T. Robinson, General Electric Co., Schenectady, N. Y.; Capt. C. A. Barton, Rock Island arsenal; Capt. B. S. Munch, Springfield arsenal; C. R. Tallcot, Watervliet arsenal; D. M. Petty, Association of Iron and Steel Electrical Engineers; W. R. Rasmussen, Pittsburgh representative of the National Safety council; F. H. Trego, Mine Safety Appliance Co., and Samuel A. Taylor, Pittsburgh; Edwin F. Sweet, assistant secretary of commerce; Dr. W. S. Stratton, director, bureau of standards, and Comfort A. Adams, chairman, American engineering standards committee.

Book Review

Personal Efficiency, by Robert Grimshaw; cloth; 218 pages, 5 x 7½ inches; published by the Macmillan Co. and furnished by THE FOUNDRY for $1.50 net.

"Efficiency is a quality of mind, or of body, producing, or capable of producing, maximum result with a given effort, or a given result with minimum effort; akin to buying a maximum amount of goods with a given sum of money, or a given amount with a minimum outlay." Such is the broad, general definition of efficiency as given by the author of "Personal Efficiency." From this he elaborates his definition to explain different forms of efficiency and to show how strenuousness and effectiveness are not necessarily indications of efficiency. In the examples of efficiency which follow these explanations, the people of the United States, taken as a nation, are arraigned as being generally inefficient—in government, transportation system, manufacturing methods, agriculture even to the housewife in her kitchen and the theatrical producer in his playhouse.

That this inefficiency can, to a great extent, be eradicated is demonstrated in the remainder of the book which is devoted to a study of the psychological and physiological human attributes, the development of which are necessary for efficient action. A healthy body and a healthy mind are the two prime requisites. How these can be attained, or as nearly so as the natural capacity of the individual permits, is explained.

The training of our senses to function quickly and accurately is stressed by the author as is also the desirability of forming habits which from their automatic character make for efficiency. If the senses transmit accurate information speedily to the brain and it, in turn, is trained to grasp the facts presented, draw logical conclusions from them, and store the whole away for future reference the battle is half won.

However, the physical condition of an individual striving for personal efficiency is also of great importance. To the laboring man a strong body is a necessity and to the executive it is a valuable adjunct to his mental strength. Simple rules for preserving health are given and fatigue and its effect on efficiency are discussed.

The well-trained mind is a priceless asset, but it can not carry in it all the material needed by the average individual. One chapter of the book, therefore, is devoted to a discussion of the value of records and standards. Other phases of the problem are treated and each is explained.

Installs Heat-Treating Plant

The Electric Furnace Co., Alliance, O., has received a contract from the Standard Roller Bearing Co., Philadelphia, for a 190-kilowatt continuous, automatic, heat-treating plant. The set consists of one 150-kilowatt electric furnace for hardening and one 40-kilowatt electrically-heated oil drawing bath.

Erects New Buildings

The Vernon, Cal., plant of the Whiting Mead Commercial Co., Los Angeles, is being extended by the erection of buildings which will add about 6000 square feet of floor space. New equipment will be installed which will include a cupola, air compressor and molding machines. This equipment will be purchased by James Bunger, superintendent of foundries.

James A. Butler and F. Albert Hayes have organized the firm of Butler & Hayes, Inc., mechanical and chemical consultants and experimental engineers, with headquarters at 220 Devonshire street, Boston.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.....Prince's Chambers
CHICAGO.....1147 Peoples Gas Bldg.
CINCINNATI.....128 Opera Place
NEW YORK.....2203-2206 St. Paul Bldg.
PHILADELPHIA.....1316 Land Title Bldg.
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WASHINGTON, D. C.....40 Metzerott Bldg.

SUBSCRIPTION

United States and Mexico.....$1.00 a year
Canada.....$1.50 a year
Great Britain and other Foreign Countries.....Eight Shillings
Single Copies.....15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

ENTERED AT THE POST OFFICE AT CLEVELAND AS SECOND CLASS MATTER

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Cut the Red Tape

PROGRESS is being made in the readjustment from a war to a peace basis, but this could be greatly accelerated if congress would speed-up the consideration of measures for the relief of contractors whose payments are being held up by a technicality in the existing law, limiting payments solely to signed contracts. It is estimated that approximately $1,500,000,000 temporarily is being withheld from the channels of industry and in some cases receiverships will be applied for unless early payments are made. The miles of red tape that apparently bind every government transaction are as much in evidence today as before the war. By legislation alone does it seem possible to cut these ties. But whatever is needed, let's have it and have it quick.

Trade Outlook

TO forecast the future with any degree of certainty is difficult, because the termination of the war is not a sufficient distance behind us to clarify the business atmosphere. However, we are slowly emerging from the cross-currents of trade introduced by hostilites to the pathway of peace. Government aid in the settlement of war contracts would speed the journey. Slight price recessions also have had a halting influence. Nevertheless,at not a very distant date an avalanche of orders for castings will engulf the foundries and everything should be done to hasten the day. Steel casting manufacturers have marked down their product $5.00 a ton and concessions have been made by gray and malleable iron plants. The reduction of $3.00 per ton on pig iron, however, has not developed a decernible buying movement.

Women in Casting Plants

SINCE the close of the war an insufficient turnover of labor has been made in foundries to define definitely the future status of women in these shops. That they will continue to be employed at coremaking is certain. At this line of work they have demonstrated their superior efficiency and when provided with the proper jigs and other equipment their production is large and the cores accurate. Prior to the advent of women in the cleaning, sorting and inspection departments, it always has been believed necessary to separate them from the male labor, but experiments forced upon foundrymen by the shortage of help has demonstrated that the sexes mingle with a minimum of friction and annoyance. In a few shops women are operating molding machines on light work, but it is a question whether they will continue to be so employed. As crane operators, however, they have made good and have developed a peculiar aptness for handling this conveying equipment. A study now is being made by the Red Cross of the employment of blinded soldiers in core shops. This probably is the only department of a casting plant to which they could be adapted. A feature in favor of the blind at making cores, is the fact that spoiled work would not involve the loss of material of value.

COMINGS AND GOINGS OF FOUNDRYMEN

F. W. Reisman has established a branch office of the Quigley Furnace Specialties Co., New York, in the Turks Head building, Providence, R. I.

William J. Fairbairn, secretary of the Milwaukee Metal Trades and Founders association, has been elected vice president of the citizens' committee on unemployment.

Herbert W. Gledhill, formerly sales engineer of the Philadelphia office of the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has been appointed district manager.

Thomas W. Pangborn, president of the Pangborn Corp., Hagerstown, Md., manufacturer of sand blast equipment, has been elected a director of the Maryland Surety & Trust Co. of that city.

M. Thomas O'Leary, president and treasurer of the Pond Machine & Foundry Co., Worcester, Mass., has been elected a director of the Merchants National bank of that city.

J. J. Newhart, formerly with the Standard Brake Shoe & Foundry Co., Pine Bluff, Ark., has been appointed foundry superintendent of the T. L. Smith Co., Milwaukee.

Patrick McManus has resumed his active connection with the Northern Foundry Co., Marinette, Wis., of which he is vice president, following the completion of his work as sheriff of Milwaukee county.

Lieut. Richard K. Durkan, formerly manager of the Warren Steel Casting Co., St. Louis, was wounded in action on Oct. 12, but has recovered and has rejoined his regiment in the vicinity of Coblenz, Germany.

J. R. McWane, who has been serving under the Emergency Fleet corporation, has resigned to resume his duties as president of the American Cast Iron Pipe Co., Birmingham, Ala. Rumsey and Leland Woodworth.

Angelo R. Clas has been made president and general manager of the Lewis Steel Co., Toledo, O., in which he has acquired an interest. Mr. Clas was previously secretary-treasurer of the Falls Motors Corp., Sheboygan Falls, Wis.

A. Robertson has been appointed manager of the Sharon, Pa., plant of the American Steel Foundries, Chicago. He succeeds W. C. Fletcher, resigned. A. D. Allen, formerly production manager of the plant, will be Mr. Robertson's assistant.

H. K. Schock, chemist, until recently affiliated with the bureau of standards, Washington, D. C., and George R. Cowan, briquetting engineer, late of Ellington field, Texas, have resumed their positions with the General Briquetting Co., 25 Broad street, New York.

M. B. Linehan, formerly president and superintendent of the Mansfield Foundry Co., Mansfield, Mass., has disposed of his interest and has accepted a position to become superintendent of the foundry operated by the Wizard Mfg. Co., North Attleboro, Mass.

B. S. McConnell, formerly Ohio and Michigan representative of the wood block flooring department of the Republic Creosoting Co., Indianapolis, with headquarters in Cleveland, has been appointed manager of the wood block department of this company with headquarters at the home office.

George B. Jones, who was affiliated with the Globe Stove & Range Co., Kokomo, Ind., for a period of 19 years in the capacity of superintendent and assistant general manager, has resigned to accept the position of general manager of the Hoosier Iron Works of that city.

James Bunger has been appointed superintendent of the foundries operated by the Whiting Mead Commercial Co., Los Angeles, Cal., with shops at Vernon and Upland, Cal. Mr. Bunger formerly was superintendent of the Baker Iron Works, Los Angeles.

S. Englebretson, formerly associated with the steel foundry operated by the Hart-Parr Co., Charles City, Iowa, and the Bettendorf Co., Bettendorf, Iowa, has been appointed superintendent of the Held Steel Casting Co.'s plant, Harvey, Ill., which is controlled by the Chicago Malleable Castings Co., Chicago.

G. K. Hooper and A. Falkenau, principals of the Hooper-Falkenau Engineering Co., New York, have retired from the ordnance department of the United States army, where they served under the commission of majors and again will devote their combined efforts to engineering work. They will specialize in plant appraisals and reorganization. The offices of the Hooper-Falkenau Engineering Co. are located at 103 Park avenue, New York.

Frank Cordes, president of the Hubbard Steel Foundry Co., East Chicago, Ind., has retired from active affiliation with the business of the company and has been succeeded by Albert Pack, formerly vice president and treasurer. William J. Gilmore retains his position as general manager and becomes vice president in succession to Mr. Pack. Jay T. Osler is works manager and F. G. Becker retains his position as secretary and in addition assumes the position of treasurer.

H. W. Clarke has been appointed manager of advertising for the Chicago Pneumatic Tool Co., Chicago. Mr. Clarke has been identified with the engineering advertising field for a number of years. Until Dec. 15, last year, he was affiliated with the advertising service department of the McGraw-Hill Co., at Chicago, and prior to his connection with these publications he was associated for eight years with the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Charles J. Menzemer has been appointed manager of the branch office recently established by Frederic B. Stevens, Detroit, at Erie, Pa. A full line of foundry facings and supplies, and polishers' and platers' supplies are carried in stock in a warehouse at Erie.

A. A. Heller, treasurer and general manager of the International Oxygen Co., New York, has given up his managerial duties, but will continue as a treasurer in charge of the financial departments of the business. Eugene Schoen has been appointed general manager.

Chicago Foundrymen's Club Elects Officers

At a meeting of the Chicago Foundrymen's club held Saturday, Jan. 11, officers for the ensuing year were elected as follows: President, A. W. Lemme, Chicago Bearing Metal Co.; vice president, Edward O'Connor, Deering Works, International Harvester Co.; secretary-treasurer, George H. Manlove, associate editor THE FOUNDRY.

To fill the vacancies on the board of directors the following were elected: R. T. Martin, McCormick Works, International Harvester Co.; H. W. Ufer, Griffin Wheel Co.; A. J. Moore, Ferguson & Lange Foundry Co., and John E. Schindler, Garden City Foundry Co.

New England Foundrymen Elect Officers

At the twenty-fourth annual meeting of the New England Foundrymen's association, held at the Exchange club, Boston, Wednesday, Jan. 8, officers for the ensuing year were elected as follows:

President, Robert L. Newcomb, Deane Steam Pump Works, Holyoke, Mass.; vice president, A. B. Root,

Hunt, Spiller Mfg. Corp., Boston; treasurer, George H. Gibby, Gibby Foundry Co., East Boston, Mass., and secretary, Fred F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass.

The new executive committee consists of the following members:

Charles A. Reed, Reed, Fears & Miller, Boston; Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., and Charles T. Colvin, Colvin Foundry Co., Providence, R. I.; Charles L. Taylor, Taylor & Fenn Co., Hartford, Conn., and C. S. Lovell, Walker-Pratt Mfg. Co., Watertown, Mass.

ARRANGEMENT OF FACING SAND MIXERS IN McCORD & CO. STEEL FOUNDRY

Efficient Layout for Facing Sand Mixers

Four-pan or muller type mixers are required to prepare the sand in the steel foundry of McCord & Co., West Pullman, Chicago. This company avails itself fully of the use of machine power in substitution for human labor, when possible, as is evidenced by the accompanying illustration. It was found that facing sand could be mixed advantageously in two mixers of the type shown. These are 6-foot pan mixers capable of handling from 7 to 8 cubic feet per batch. The arrangement illustrated was adopted to economize in time of delivery from the mixers to the floor, as one bucket may serve to remove the mixed sand from the two machines.

The mixers and bucket loaders are unit in construction. They are set into a pit adjacent to the sand storage bins and are so located that a full batch may be shoveled directly into the hoppers, while the previous charge is in the mixer. The loader at the left is shown in position to receive its charge. When the previous batch is dumped, a clutch is engaged with the main drive shaft of the mixer. This transmits power to a shaft to which is keyed a winding drum, about which a cable is wound. Winding the cable over the pulley at the top of the framework of the loading device, coils the cables over the two smaller pulleys and raises the hopper to the position shown at the right, when the new charge is delivered to the mixer.

After mixing in the manner which is familiar to this type of machine, a drop gate or door in the bottom of the pan permits the mixed material to fall into the sand bucket between the two machines. Both machines discharge into this same bucket which delivers its charge while new batches are mixed.

The four units used by McCord & Co. were constructed by the National Engineering Co., Chicago.

Malleable Furnace Bung Distributes Blast

For the purpose of effecting a more uniform distribution of air on the metal bath of malleable iron and other air furnaces, the bung shown in the accompanying illustrations, was devised by William S. Robinson, superintendent of the Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., to whom a patent recently was issued covering this device. The bung frame which is similar in construction to bung frames generally employed, is provided with an air cylinder that is cast the full length of the top of the bung, as illustrated in the various views, Fig. 1. This cylinder is closed entirely at one end, but at the opposite end an opening is provided for the air blast. Brick are inserted in the bung in a slotted manner to effect the uniform distribution of the air blast across the entire width of the furnace as shown at *B*, Fig. 2. In the event of brick falling out of this bung, the entire bung can be replaced just as readily as any other bung in the furnace and this may be accomplished without working over the top of the furnace.

This type of bung has been used at the plant of the Benton Harbor Malleable Foundry Co. for about a year and according to carefully compiled records, it has effected a saving of from 10 to 25 per cent in fire brick and economies in coal consumption of about

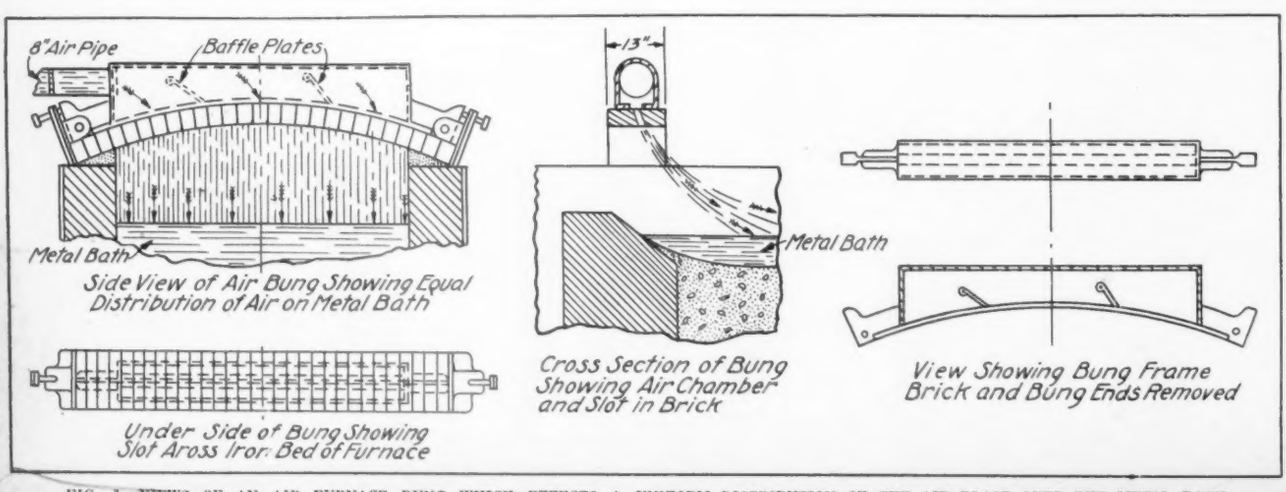
8" Air Pipe
Baffle Plates
Metal Bath
Side View of Air Bung Showing Equal Distribution of Air on Metal Bath
13"
Metal Bath
Cross Section of Bung Showing Air Chamber and Slot in Brick
View Showing Bung Frame Brick and Bung Ends Removed
Under Side of Bung Showing Slot Across Iron Bed of Furnace

FIG. 1—VIEWS OF AN AIR FURNACE BUNG WHICH EFFECTS A UNIFORM DISTRIBUTION OF THE AIR BLAST OVER THE METAL BATH

the same amount. The saving in fuel is claimed to be due to the improved combustion and better distribution of the air. Also, the time of melting has been reduced from 30 to 40 minutes and the iron so made is of a higher temperature than can otherwise be obtained. The bung shown at *A*, Fig. 2, has been used for 83 heats and while it was installed in the furnace 1400 tons of iron were melted. In addition to the economies effected in the bung brick, it has been found that the entire roof of the furnace gives a longer life and the side walls are more durable.

Publishes Temperature Tables

Concise information in the most usable form is presented in a 175-page book of tables published by the Taylor Instrument Co., Rochester, N. Y. This publication is in effect a handbook which fills the space left by the tangency between tabular data compiled for mechanical, civil and metallurgical engineers. Every conceiveable phase of temperature problems is met in this book by some kind of data which form a basis for computation.

Equivalent temperature readings for Fahrenheit and Centigrade scales from absolute zero to 3630 degrees Fahr. are presented. Pressure-temperature table for saturated steam and for ammonia vapors occupy another section. Wet and dry bulb readings with equivalent humidity tables follow a complete description of the working principles of the hygrometer. The use of the hydrometer in determining specific gravity and the practical value of this instrument in grading fuel and lubricating oils precedes tables of corrections for readings. The explanation of heating units, power and electrical units serves to introduce tables of melting points, and heats of combustion of the various chemical elements. General information relative to atomic weights, decimal or metric equivalents, gage comparison followed by tables of domestic and foreign weights and measures occupy the last 25 pages of this valuable handbook.

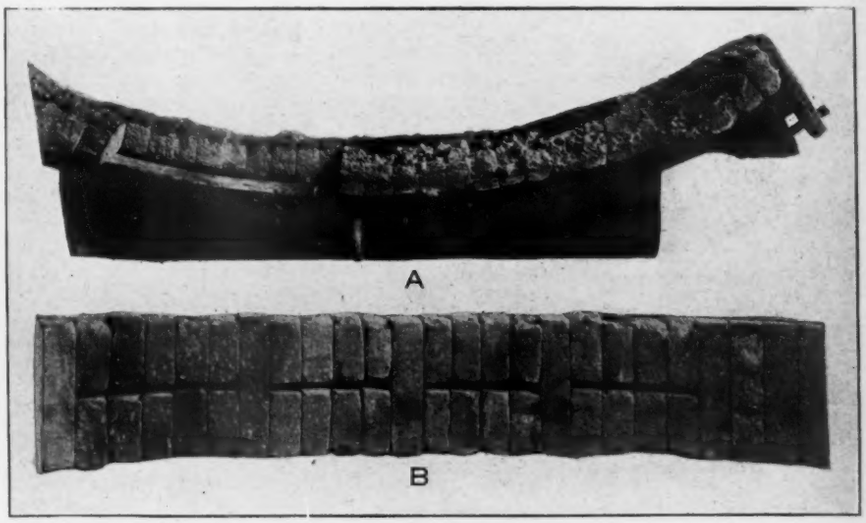

FIG. 2—A FURNACE BUNG THAT HAS A RECORD OF 83 HEATS IS ILLUSTRATED AT A AND B SHOWING THE ARRANGEMENT OF THE BRICK WITH SLOTS FOR THE PASSAGE OF THE AIR BLAST

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The foundry of the LeRoy Plow Co., Le Roy, N. Y., recently was damaged by fire.

The foundry department of Rathbone Sard & Co., Albany, N. Y., recently was damaged by fire.

The Sandusky Foundry & Machine Co., Sandusky, O., recently completed an addition to its foundry.

The Brownwood Foundry & Machine Co., Brownwood, Tex., recently was damaged by fire.

A plant addition is being erected by the Atlas Foundry Co., 234 Artillery avenue, Detroit.

The foundry of the Columbus Iron Works, Columbus, Ga., recently was badly damaged by fire.

The Royal Machine Co., Philadelphia, has awarded a contract for a 35 x 65-foot foundry addition.

The Chase Foundry & Mfg. Co., Columbus, O., is erecting a plant to replace the one damaged by fire.

The Toledo Machine & Tool Co., Toledo, O., plans the erection of a machine shop and foundry.

O. J. Cavanaugh & Co., Tilbury, Ont., plans the erection of a foundry.

The Southern Wire & Iron Works, Atlanta, Ga., plans to enlarge its foundry.

The Columbiana Foundry Co., Youngstown, O., recently increased its capital from $10,000 to $30,000.

The Ohio Steel Foundry Co., Lima, O., has let a contract for the erection of an addition.

The Ironton Engine Co., Ironton, O., is installing additional equipment in its foundry.

Contracts have been awarded for the erection of an addition to the Canadian Steel Foundries, 120 St. James street, Montreal, Que.

Fire recently damaged the plant of the Geyer & Grandeau Foundry Co., Rocky Hill, Conn.

The Pan Motor Co., St. Cloud, Minn., contemplates erecting a foundry, 130 x 180 feet.

The Lake Union Foundry Co., Seattle, recently was incorporated with $5000 capital, by W. A. Wadleigh and others of Seattle.

Fred R. Slater, Superior, Wis., has had plans prepared for the erection of a small addition to his foundry at 1001 Winter street.

The Generator Valve Co., William James, president, 37-53 Dinsmore place, Brooklyn, N. Y., is having plans drawn for a foundry, 25 x 57 feet.

O. A. Potts, 402 Carroll street, Youngstown, O., is taking bids for the erection of a foundry, 50 x 100 feet.

The Essex Foundry Co., Murray street and D avenue, Newark, N. J., has let a contract for the erection of a small addition.

The Packard Motor Car Co., Detroit, has let a contract for the erection of an addition to its foundry.

The Vortex Mfg. Co., Chicago, purchased property on Austin avenue, which is improved by a foundry building.

The Quaker Mfg. Co., Chicago, has acquired from the Federal Foundry Co., the latter's plant in Chicago Heights.

The Wizard Mfg. Co., North Attleboro, Mass., is building a 35 x 100-foot addition to its foundry.

The foundry of the Griffin Wheel Co., Chelsea, Mass., recently was badly damaged by fire.

The Nash Motors Co., Kenosha, Wis., is building a 180-foot extension to its foundry.

The Philadelphia Roll & Machine Co., Twenty-third and Carpenter streets, Philadelphia, will build an addition to its foundry, 35 x 63 feet.

Robert La Pointe and others of Hartford, Wis., plan to open a foundry to be known as the Hartford Foundry Co.

The Osborne Casting Co., Larard avenue, Racine, Wis., will begin work soon on an addition to its foundry.

The Ulster Foundry Corp., New York, recently was incorporated with $100,000 capital, by J. A. Warrie, A. A. Hebert and E. H. Mays of 50 Church street.

The Weatherly Foundry & Machine Co., Weatherly, Pa., has acquired 15 acres adjoining its plant, for extensions.

The International Harvester Corp., 606 South Michigan avenue, Chicago, is building another foundry at its Plano works, West Pullman, Ill.

The Chicago Steel Foundry Co., Kedzie avenue, Chicago, awarded a contract for the building of an addition, 30 x 60 feet.

The Sawyer Brass & Iron Foundry, Joseph S. Sawyer, president, East Oneida street, Oswego, N. Y.,

is having plans drawn for a foundry, 65 x 165 feet.

Bids will be taken in the spring for the erection of a foundry addition at the plant of the Crompton & Knowles Loom Works, Worcester, Mass.

The W. S. Hawes Foundry & Equipment Co., 44 Steubens street, New York, is having plans prepared for additions to its plant.

The Semi-Steel Test Foundry Co., 4916 Bloomingdale avenue, Chicago, plans to build a 50 x 85-foot foundry.

The Missouri Malleable Iron Co., Fifteenth and Brady streets, East St. Louis, Ill., will build a 23 x 150-foot foundry.

The Keystone Iron Works, 959 North Main street, Los Angeles, Cal., is having plans prepared for a plant, to include a machine shop and foundry.

The Pacific Foundry Co., Tacoma, Wash., recently was incorporated with $10,000 capital, by Edward Simpson and F. J. Walsh.

The United States railroad administration, Pacific coast section, San Francisco, plans the erection of a steel foundry.

The Dallas Foundry Co., Dallas, Oreg., recently organized, has purchased a plant which it will remodel.

A machine shop and foundry owned by Charles E. Babbitt, 440 Fore street, Portland, Me., recently was damaged by fire.

The Hartley Foundries, Ltd., Brantford, Ont., has been incorporated with $100,000 capital, by F. A. Hartley, R. A. Hartley and Daniel Spencer.

The Watson-Frye Co., Ltd., Bath, Me., recently was incorporated to do a general machine shop and foundry business, with $500,000 capital, by Scott R. Frye and Ralph O. Dale.

The Tri-State Foundry & Machine Co., Wellsburg, W. Va., has acquired a 5-acre site in Warren, O., and plans the erection of a foundry and machine shop.

The bureau of yards and docks, Washington, D. C., recently let a contract to the Evatt Construction Co. for the erection of additions to the machine shop and foundry at the Charlestown navy yard, Boston.

Reorganization of the Romeo Foundry Co. into the Holmes Foundry Co. at Port Huron, Mich., has been announced. The new company is capitalized at $1,250,000. L. A. Holmes heads the company.

The Michigan Press Co., Ypsilanti, Mich., has increased its capital from $100,000 to $300,000 and has changed its name to the Michigan Machine Tool & Foundry Co. The plant will be enlarged.

The Royal Mfg. & Foundry Co., Oshkosh, Wis., has been chartered to take over the business of the Schloemer Mfg. Co. and to conduct a foundry and welding shop. The company is capitalized at $30,000.

The Tidewater Foundry Co., 404 Nivision street, Norfolk, Va., has been incorporated with a capital of $5000, by C. L. Hughes, O. L. Keeter and others of South Norfolk.

To provide for an increase in output, the Northern Foundry Co., Marinette, Wis., increased its capital stock from $25,000 to $95,000. The company is building additions.

The Service Foundry Co., Brazil, Ind., has been organized by D. M. Crawford and others, to do a general foundry business. It has taken over a plant on South Depot street, Brazil, which it will enlarge.

The Becker Mfg. Co., Two Rivers, Wis., has been incorporated with $25,000 capital, to conduct a foundry. The incorporators are Michael P. Annie and Frank T. Becker.

The General Motors Co., Detroit, is erecting a gray iron foundry at Saginaw, Mich., and is remodeling the plant occupied during the war by the Peninsular Shell Co.

The Backus Heater & Foundry Co., Boston, recently was incorporated with $50,000 capital, by William J. Townsend, Walter P. Spring and George F. Briggan.

The Acme Foundry Co., Chelsea, Mass., recently was incorporated with $50,000 capital, by Oscar Anderson, Everett, Mass., George P. Bugley and William T. O'Brien, both of Boston.

Louis Sacks, operating a foundry on Wilson avenue, Newark, N. J., has filed notice of the organization of the Louis Sacks Iron Foundry, the Brass Founders' Supply Co. and the Star Heel Plate Co. Louis Sacks, Inc., is the parent organization.

The Flower Stephens Mfg. Co., J. W. Flower, Clayton and Parkinson avenues, Detroit, has let a contract for the erection of a foundry addition, 37 x 150 feet, to A. R. Yope & Co., 803 Kresge building.

The Southwestern Steel Co., Sand Springs, Okla., chartered several months ago with $500,000 capital, is erecting a large foundry and buildings for other departments. J. W. Sherman, Springfield, Mo., is president of the company.

A. C. Penn, Inc., Newark, N. J., manufacturer of safety razors, has leased space from the Universal Castor & Foundry Co.

The Bath Machine Works, Inc., Bath, N. Y., recently was incorporated with $150,000 capital, to operate a machine shop and foundry. The incorporators are F. L. Robinson, V. A. St. John and R. A. Watkins, Bath, N. Y.

The Murray Co., Atlanta, Ga., manufacturer of cotton seed oil and cotton ginning machinery, will increase the capacity of its plant by the erection of another gray iron foundry, 72 x 200 feet. Lockwood, Greene & Co., engineers and architects of Atlanta, will handle the construction work.

NEW TRADE PUBLICATIONS

BLOWERS.—The extensive line of rotary blowers built by the P. H. & F. M. Roots Co., Connersville, Ind., is illustrated and described in a 48-page catalog, recently issued. In addition to this line of blowers, the Roots company manufactures gas, water and vacuum pumps. The low pressure type of blowers, made for foundry purposes, occupies a large portion of this catalog. This type of blower needs no introduction to foundrymen since it has been a standard part of their equipment for many years. Both belt and motor-driven units are illustrated and a table of sizes and capacities as well as instructions for the selection of foundry blowers, are included. A number of interesting installation views likewise are presented. Blowers for oil and gas furnaces also are shown, as well as machines for furnishing the blast for steel converters. High pressure type blowers also are illustrated and described in detail and a valuable table of capacities and dimensions for pressures from two to nine pounds is given. Wind and blast gates, flexible coupling, nonvibrating relief valves, etc., also are shown. Tables giving directly the pressure needed to transmit the given quantity of air through a pipe 100 feet long and the flow of air through orifices will prove of value to all engineers.

COAL HANDLING EQUIPMENT.—In an 88-page catalog the Link-Belt Co., Chicago, illustrates and describes its extensive line of equipment for the handling and preparation of coal at the mine. Various types of tipples and conveyors installed at different mines are illustrated and detailed views of the component parts of this equipment also are included. Methods of storing coal are described as well as picking tables, conveyors, coal washeries, driers, crushers, portable loaders, etc.

BUILDINGS.—The engineering and construction service rendered by the Gaylord W. Feaga Co., Cleveland, is described in a handsome 24-page catalog recently issued by this company. In the erection of industrial buildings speed is an essential factor and it is pointed out that the Feaga Co., within 15 days after it had received the order, planned and built complete for the Willard Storage Battery Co., Cleveland, a brick, trussed roof and glass structure, 90 x 202 feet, of special truss design with two monitors. Since the builders were handicapped by the severity of a Cleveland winter, all the operations were carried on under a large tent. Another record also was established at this plant on a reinforced concrete structure, 222 x 134 feet, the first story having been flat slab construction and the second story the same kind of construction as the 15-day building, except that it was provided with three monitors. This entire structural building was erected in 45 days. Interesting views of numerous industrial buildings of standardized design are included and a list also is published of representative clients, containing the names of some of the largest companies in the country.

MATERIAL BINS.—Materials storage and transfer through the aid of overhead bins or hoppers are treated at length in an illustrated booklet prepared for the Green Engineering Co., East Chicago, Ind. The bins described employ cast iron wherever construction elements are exposed to rusting or abrasive action of stored materials. The supporting framework is built of standard steel sections, cut and punched ready for erection and bolting. The cast iron plate supports are hooked upon this frame and cast iron side and corner plates are fitted into recesses in the sides of these supports. The hoppers are adapted to the storage of coal, ash, crushed rock, sand, coke, etc.

CLAM SHELL BUCKETS.—The automatic single line clam shell buckets, manufactured by the Blaw-Knox Co., Pittsburgh, are illustrated and briefly described in a handsome 20-page booklet. These buckets are hooked on and off the block of any type of crane or derrick, leaving the equipment free for other work when the bucket is not required. These buckets may be used to advantage in all kinds of industrial operations, for loading and unloading cars of coal, sand, gravel, etc.; for cleaning ash, mill scale or cinder pits; for distributing sand in foundries; rehandling other bulk materials, etc. A number of operating views are included, as well as a table of dimensions, list of parts and accessories.

PNEUMATIC TOOLS.—The Independent Pneumatic Tool Co., Chicago, has issued a 4-page bulletin which briefly describes a large number of its various types of pneumatic and electric tools for drilling, reaming, grinding, etc. Several types of pneumatic riveting and chipping hammers with inside and outside triggers also are described and illustrated.

FOUNDRY SUPPLIES AND EQUIPMENT.—A pretentious 400-page catalog, devoted exclusively to foundry supplies and equipment, is being distributed to the trade by the Buckeye Products Co., Cincinnati. This catalog is the measure of the progress made by this company in a period of only 10 years. In the summer of 1908 a partnership was effected, of which this company is the outgrowth, for the purpose of manufacturing and introducing to the trade a parting compound. Subsequently the company was incorporated and other lines of supplies for the foundry trade were added from time to time. Today practically all supplies used in casting plants, either are produced or carried in stock and almost every conceivable type of foundry equipment also may be furnished. The line of brass foundry equipment manufactured consists of stationary and tilting crucible furnaces, noncrucible open-flame furnaces, etc., for operation with gas or oil for fuel. The catalog is well indexed and will prove a valuable addition to the trade literature of foundrymen generally.